A

TREATISE ON PHYSIOLOGY

APPLIED

TO PATHOLOGY.

BY

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PREFACE BY THE TRANSLATORS.

Physiology is indebted to Haller for its being freed from the theories of the chemists and mechanical philosophers. He was the first to show, by his experiments on irritability, that the series of phenomena, to which we apply the term life, in an organized body, is the result of peculiar laws of action, inimitable by all the conjoined efforts of art and science. The inductions which he drew from this discovery, were, however, unfortunately suffered to remain among those abstract truths, the precise purport and application of which are often long in being detected. A different and happier fate attended the physiological inquiries of Bordeu. The positions which he laid down, and which served as the ground-work to the magnificent creation of Bichat, were, that man is a compound of various organs, each of which has specific movements and actions, and enjoys alternate activity and repose; that the organs possessed by all individuals are the brain, heart, and stomach, which may be regarded as the triune of the human frame, and the true supporters of life; and that the body is to be considered as composed of two lateral and symmetrical parts.

The labours of this celebrated genius constitute a remarkable era in medicine. It is admitted by all, that the laws of gravitation and attraction can never, by any subtlety of reasoning or refinement of language, be lost sight of, because they are necessarily and intimately connected with the movements of matter, whether in the revolution of orb around orb, or in minute molecular changes. With nearly equal propriety, we may say that the laws of the vital functions cannot now, by any metaphysical abstraction or deceptive scientific analogies, be misunderstood or perverted, because they are founded on the observed nature and properties of the organized elements or tissues, the play of organ upon organ, the sympathy of membrane with membrane. Though perhaps it ar-

gues a too sanguine spirit, we feel inclined to place the services which Bichat has rendered to medicine in his General Anatomy, on a parallel line with the benefits conferred on astronomy and natural philosophy by Newton in his *Principia.* National prejudice and the pride of old opinions have retarded the diffusion of the works of both these benefactors to their species. It was reserved for a Voltaire to eventually give currency to the principles of Newton in France. Has Bichat yet found a worthy and impressive commentator in England? More than twenty years were allowed to elapse before his great work was translated in that country, and then not until the task had been first performed by an American physician!*

We are the more solicitous, on the present occasion, to direct the attention of our readers in an especial manner to the labours of Bichat in physiology, not merely for the purposes of a retrospective history of that science, but in order that a knowledge of them may be duly estimated, as a necessary and indispensable condition for the full and clear understanding of the author, whose work we have translated. It is a truth, far from being sufficiently and diffusively known, that M. Broussais is the practical commentator and expounder of the General Anatomy, to which he has given an extension and diversified application, similar for the purposes of medicine, to what the first books of Euclid have received in surveying and navigation. They who have tasked their ingenuity, and wearied themselves in bibliographical research, with a view to detect what they are pleased to call the source of his theory, ought to be apprized of his own frank and manly acknowledgment, which we have heard him make to his class, viz. that his chief merit and ambition consisted in carrying out the ideas of Bichat, and adapting them to the pathology of disease and the practice of medicine. Where, in fact, but in the doctrine of the tissues did he imbibe his dislike to ontology, and his scepticism of the alleged specific syphilitic and scrofulous viruses—where, but from the author of the work on the *Membranes*, did he derive his opinions respecting the dependence of the various secreting organs on the surfaces on which they open.

The cause of medicine has suffered, as well from the neglect of physiology, as from the defective method of teaching it. Functions have been described in the abstract, without a due attention to the modifying agents of hygeine, and the gradual conversion of the

* Dr. Haywood, of Boston.

phenomena of health into the painful disturbances of disease. That this is not an exaggerated representation of the imperfection to which we have alluded may readily be found on an examination of the writings extant on physiology and pathology. By such an examination, the reader will discover that it was for a long time customary to separate these branches, and to regard them as distinct from, or at least as exerting a very limited influence over, each other. In all the schemes of medical education, we were directed to study the functions as performed in the natural condition of the system; and all the works published on physiology were filled with lengthened disquisitions on the mechanism and play of these functions, without reference, except in a few instances, to the application that could be made of the phenomena described to the investigation of the diseased state. In a word, physiology appeared to be considered as a science calculated rather to amuse than to prove of direct or positive utility to those who engaged in its study; as a division or branch of the general science, presenting as strong attractions, and offering as many advantages to the general inquirer, as to the individual who applied himself to the attainment of medical knowledge.

Pathology, in its turn, was made the subject of simultaneous, though oftener of subsequent study ; but it was invariably considered as a distinct branch, having a remote, if any connexion with physiology. Pathological facts were viewed as diametrically opposed to—of a nature essentially different from, the phenomena of the healthy state ;—in no instance was the manner in which the normal action of an organ becomes deranged, in consequence of the undue exercise of the latter, or of some distant parts, or in consequence of the impression of external agents, clearly understood, and the majority of diseases were explained by means of morbific humours, vices, and viruses, which were supposed to float in various directions, to give rise to local complaints and general disorder, and to require, before health could be re-established, to be eliminated from the system.

It cannot have escaped the notice of the inquiring physician, of him, who, while acquainted with the present state of professional knowledge, does not despise the labours of his predecessors, so much as to neglect entirely the works that have been transmitted to us, that, within a comparatively short period, a happy revolution has occurred in the science of medicine ; and that the views we have briefly sketched, after experiencing various modifications,

have finally given way to others of a different and more effective kind. Physiology consists now, more than it did formerly, in the study of the vital properties of the tissues; and, thanks to a better method of philosophising which has found its way among the cultivators of that science, we indulge much less than our predecessors, in abstruse hypotheses, on subjects which by their very nature are placed beyond reach of the powers of human understanding. While this reform was being effected in physiology, corresponding, and as important changes have been made in pathology. This science has been cleared of the superannuated doctrines about viruses, vitiated humours, &c. by which it had so long been obscured—all the ingenious, and oftentimes wild hypothesis about general diseases, which, though pervading the whole economy, were not considered as affecting any organ in particular, and consequently were separate from the tissues, have been gradually consigned to merited oblivion. In the progress of time, diseases have been shown to be located almost exclusively in the solids of the tissues and organs, and to consist in a derangement of the organic action of those parts; in a word, pathology has been founded on a knowledge of the vital properties, which constitutes the science of physiology.

The physicians of modern times, in adopting conclusions to which they appear to have been unavoidably led by the more favourable direction imparted to the science of medicine, in its progress towards perfection, and particularly by the improvements made in physiology and pathology, have conferred a great benefit on these latter, and, as a consequence, on the practice of medicine. This result has, without doubt, been obtained by a reform in the principles of the two branches which occupy at present our attention, and by showing the advantage of applying physiology to pathology.

The materials had been long in the hands of the profession, and yet they were not turned to any positive advantage, until employed by a few men of genius whom it pleased providence to entrust with the important mission of reform.

While maintaining this, however, it is far from our desire to be understood as affirming, that until recently, pathologists never attended to physiology, and did not base their views of the nature and character of disease on a knowledge of the phenomena and properties of life. Were a physician to hazard such an assertion, he would betray a very limited acquaintance with the medical literature of former years. So far, indeed, for such being the fact,

it may with confidence be affirmed, that every author of note who from the earliest period in the history of our science, has made pathology the subject of his theme,—Hippocrates, Themison, and Galen, Paracelsus, Vesalius, and Van Helment, Sydenham, Glisson, and Boerhaave, Hoffman, and Stahl, and many others we could cite, have *physiologized*, if we may be allowed this expression, even, sometimes, to a considerable extent. But like the man in Moliere's play, who was surprised at finding he had spoken in prose for forty years without once perceiving it, these authors would seem to have applied physiology to pathology, without being aware of the circumstance, and would probably have expressed as much astonishment as the *bourgeois gentilhomme*, had they been apprized of their being physiological physicians. All that we mean to express, is that it is to the time of Corvisart, or perhaps more justly, to that of Bordeu, Tissot, Haller and Fabre, that the origin of the true physiology of the diseased state—the intentional application of that science to pathology, must be referred, and that to the founder and disciples of the present physiological school of France, credit is undoubtedly due for having given to that application the extension to which it has recently attained.

The author has been accused of indulging too freely in theory, and of presenting to his readers in the light of well established and uncontrovertible principles, the mere creations of his own fertile imagination, or at most the hasty conclusions drawn from insufficient data. That the charge may occasionally be well merited, we do not feel prepared to deny, nay we are free to admit, that many of M. Broussais's physiological and pathological views cannot bear the test of close examination. But that we are on that account to reject his doctrines *in toto*, or to condemn the present work, because it contains many loose and unfounded speculations, are positions which we shall certainly never be disposed to assume. The very circumstance of our presenting this work in an English dress to the professional public of our country, will we hope be regarded as an evidence of the value we attach to it, and the rapidity with which two editions have been sold, is, we believe, a sure indication that physiologists on this side of the Atlantic, do not entertain an opinion on the subject different from our own. We fear not to say that he who shall study this work, unbiassed by prejudices, and already versed in a knowledge of general anatomy, will join us in the opinion, that amid some irrelevant matter it contains enlarged and correct views of many of the operations of the animal economy.

Nor are we prepared to unite with some of the opponents of M. Broussais, in the sweeping denunciation of theory. We are ready to concede that among the causes which have been instrumental in retarding the progress of medicine, we may justly enumerate the fondness which the members of our profession have usually displayed for hypothesis—a fondness which from the days of Pliny, Lesage, and Moliere, has been ridiculed by every writer, who has made medicine or its cultivators the subject of his mirth. But even in admitting this, we are yet to learn the propriety of inferring hence that theory is of no value; that it is the only cause which has retarded the advancement of the science, or that physicians alone have constantly appeared disposed to indulge in speculation. From all that we have seen, heard, or read, on the subject, we believe it may fairly be concluded that some physicians have attached too much importance to theory, or more correctly speaking to hypothesis, and particularly to their own theories, often to the neglect of observation. But farther than this it would be hazardous to conclude, for we might be reminded that the abuse that has been made of a thing cannot serve to prove that the thing is itself of no value. Indeed, were we to reason on all subjects, in the way the anti-theorists have done in reference to medicine, we believe there are few arts and sciences, even of those dignified with the appellation of useful, that might not be proved to be destitute of useful application; or rather that could not be shown to be made up of many useless things; since, in all, we find much theory blended with the positive facts on which they are founded.

If we consult the annals of all the sciences, we shall without difficulty discover, that this fondness for speculation so unreservedly charged on physicians is far from being peculiar to them; and it does not require much attention to find, that if by them it has been displayed to a greater, and sometimes even to a reprehensible, extent, the fault should be ascribed to the peculiar nature of the subject they are called upon to investigate; the laws by which the human system is regulated in health, and their deviation in disease being more difficult to understand and explain, than those of inorganic matter, and consequently allowing a wider scope for the exercise of the imagination. While admitting, therefore, that this unrestrained fondness for speculation has been a fruitful source of injury to the progress of medicine, we repeat that we are far from feeling disposed to coincide in sentiment with those who deny, in positive terms, the utility of theory, and affect to rely exclusively on

experience. At all times, and in every enlightened country, theory has been admitted, by judicious minds, to be indispensably necessary in every department of human knowledge, and this opinion which applies with equal force to the sciences generally, does so in a more especial manner to the one which it is the province of the physician to cultivate, since the mere detail of solitary or unconnected facts can prove of little or no real utility, and " must slide imperceptibly down the tide of oblivion."

Of the correctness of this opinion, a few remarks will we trust be sufficient to convince the most sceptical. It is a fact, sufficiently obvious even to the most common observer, that no two individuals possess precisely equal degrees of physical and mental energy. Human temperaments, also, although susceptible of several grand divisions, are found to present innumerable shades of difference in various subjects, and each human being manifests his idiosyncrasy. Aware of these circumstances, it will not be difficult to understand, that diseases attacking individuals so variously circumstanced will be modified to such an extent, as to be viewed by inexperienced observers as dissimilar, whereas those who are accustomed to generalize, will discover in each case one of the many shades of the same complaint. Cases whether similar or not, must be compared; their points of analogy, if any such exist, must be carefully noted, in order that they may be referred to a distinct class, and submitted to a particular mode of treatment; or arranged with other cases of a different kind, and subjected to a corresponding difference in the curative plan. The actions of general and particular causes must be studied in reference to their effects on various organs and tissues; the operation of remedial agents on different individuals, and in different diseases, and at various periods of the same complaint; the modifications occasioned by differences of constitution, temperaments and idiosyncrasy should be distinctly noted by the physician, in order that he may be enabled to resort to these agents, in proper cases, and under appropriate circumstances, and abstain from them in affections of a different kind. The nature of the disease must, if possible, be ascertained, so that symptoms arising from a peculiar state of the organs, may not be confounded with such as arise from a contrary condition of the same parts, and which would demand a corresponding difference in the method of cure; nor should they induce the physician to believe in the existence of one state of the system, while in truth the contrary is the real state of the case. In this examina-

tion of symptoms also, those arising from primary affections must be carefully distinguished from such as are the result of a secondary or sympathetic disturbance of the organs. In fine, he who lays some claims to the appellation of a philosophical physician, should reason on what he sees with the view to deduce principles capable of guiding him in the management of the sick. Now the operation of the mind by which this is effected, is that of theorizing—reasoning in medicine, having, with great propriety, been regarded as synonymous with theory. "There are some modern practitioners," says Dr. Darwin, "who declaim against theory in general, not considering, that to think is to theorize; and that no one can direct a method of cure to a person labouring under disease without thinking; that is, without theorizing, and happy therefore is the patient, whose physician possesses the best theory."

So natural, indeed, is it to theorize, that the empiric who contents himself with applying a remedy to a symptom, without reference to the origin of the latter, or to the condition of the organ which is to receive the primary or secondary impression of his nostrum, the old and ignorant gossip who is ever ready to indicate an infallible cure for every disease—all such individnals entertain some notions respecting the nature of the case, or the *modus operandi* of their drugs. It is evident, that in doing this, they *theorize*, and that their theories commonly differ from those of the enlightened pathologist, in not being founded on a correct view of the functions of the animal economy. The greatest benefactors of our science, those individuals who have contributed most conspicuously to its progress; Boerhaave, Stahl, Cullen, Bichat, belong to that class of men whom the supporters of the doctrine of pure observation, perpetually stigmatize with the reproachful epithet of *theorist;* and yet it requires but a superficial examination to discover that the immense majority of useful facts we possess in the science, are indubitably due to theorists and speculators, whose doctrines, however evanescent they may have proved, contained amid many erroneous speculations, some valuable views which were treasured up by their successors. Experience, or as it is usually called, practice, says M. Blainville, is without doubt an important part of the art of medicine; but theory, based on the previous knowledge of all the circumstances of the phenomenon, is perhaps more so; because every man is no longer, as it were, obliged to create for himself an art proportioned to the extent of his intellectual powers, but can (if we might so express ourselves) mount on the shoulders of his predeces-

ors. Theory is important in order that the art may be enlightened in all its branches, that there may be more certainty in its application, and that the conscience of the physician may be consoled, when he is obliged to recognize the too narrow limits in which his powers are restrained. Empiricism, often decorated by the title of Hippocratic, has been frequently much extolled; but if we mark the persons who adopt this method, we shall find that it is the ordinary refuge of ignorance, or at least, of indolence. But we return from this digression.

Mechanical physiology and the study of healthy function will doubtless prove interesting to the gentleman scholar, and to the person addicted to natural history; but they are poorly calculated to meet the wants and gratify the wishes of the physician. They are as barren of results, favourable to the healing art, as is a system of Materia Medica made up of an enumeration of the sensible properties of medicines, and dogmatic statements of the diseases in which they are useful, without any explanation of their mode of operation, or the variety of effects dependent on the particular condition of the organs to which they are applied, and the intensity and duration of the morbid symptoms, which they are intended to palliate or remove.

Physiology, in the present work, is elevated from the station of a low subsidiary, to that of a guide to our science, by which the physician is led out of darkness, or the worse obscuration of the limbo of vanity. The resources of experiment and observation are conjoined, each being made to correct the other's fallacies; as when the hasty inferences from the former are revised and modified in the more safe though slower inductions of the latter.

Anatomy and pathology constitute the only sure foundation of physiology, by making us acquainted, the first with the order of precedence of structure to function, the second with the disappearance of function consequent on the destruction of structure. The primary failure of a part to be developed, as in an inferior class of animals or in monsters, shows, by the absence of a function, the office which it was destined to perform: its slow removal by the disorganizing process of disease, being productive of similar functional loss, leads us to a like conclusion as in the former case. Evidence of a middle nature is found when the energy of function is proportioned to the integrity of structure, and to the entire and ample development of an organ acted on by its appropriate stimuli. Here begins the physiology of observation, in which we add to the data

just indicated, a notice of the effects of the particular agencies, in the classes of the *circumfusa*, *applicata*, *gesta*, and *percepta*, on the organs, and the extent to which the relations between these are modified by the different epochs of life, by the seasons, and the diurnal cycle.

Let us apply these rules to the study of the nervous system, of the two divisions of which, the encephalo-spinal or voluntary, and the sympathetic or involuntary—the first presides over the functions of relation, the second over those of nutrition. In doing this we hope to place before our readers some of the leading and most important propositions of the author of this volume. Comparative anatomy and pathology, aided by an observation of the effects of growth and development, from infancy on to adult age, have enabled us to form a pretty correct estimate of the functions of the encephalon, and in a more particular manner of the cerebrum. When we see that it is entirely wanting in many of the lower animals, is at first semi-fluid, and afterwards soft and incompletely formed in the fœtal state of the more perfect ones, that it does not acquire its fulness of outline, and firmness of structure until some time after birth, and even in certain cases of monsters is totally absent, we become convinced that this part is not necessary to the growth and vigour of the rest of the body, nor to the discharge of the various functions of assimilation, and limited locomotion and sensation, since these are evinced in the above circumstances of anencephalous beings. Pursuing the same path of observation, we soon discover that the difference between the beings without brain, or in which there is little more than the rudiments of one, and those others higher in the scale, with this part more fully developed, consists in the latter displaying, in addition to instinctive movements, multiplied actions indicating thought. We rightly infer, then, that the encephalon, connected as it is with other regions of the body by means of the spinal cord and nerves, is the part where the impressions on the sensitive surfaces are received and combined; not, as may happen in common ganglia, to be followed by automatic movements, but to precede the radiation of that stimulus which gives locomotion to the human frame, for the carrying certain preconceived ideas into effect. We learn, in other words, that the encephalon is the originator and framer of mental acts, of the operations of instinct and intellect, and of moral feelings and passions. But as these endowments are not equally possessed by every animal, our next branch of inquiry is to observe

under what peculiarity of encephalic conformation they are manifested, and what is the assignable proportion between particular development and special function or faculty. The gradual growth of the brain, attended by a proportionate evolution and increased energy of the faculties of the mind, a difference in cerebral development corresponding with differences in mental energy, and a particular development constantly coinciding with a special function, are facts, which faithfully recorded of late years, have formed the foundation of a natural and satisfactory system of mental philosophy, and furnished the strongest proofs of the efficiency of physiological observation.

The inferences from pathology must harmonise with the deductions from what we see of healthy structure and coincident function, and be identical with the phenomena exhibited in monstrosities and primitive deficiency of the organ. But here let us carefully distinguish the first more violent and diffusive effects of disease, when all the parts adjacent to that first irritated, are in a state of turgescence and disturbance, owing to contiguity and sympathy, from the second or chronic, in which the vascular and nervous disorders no longer embrace a large circumference, but are restricted to the part primarily affected. It is at this time that the alteration of structure by induration, softening, or ulceration, will show negatively the office performed by the part or organ during health, in its loss of function, when it is thus changed or obliterated by disease. The phenomena immediately succeeding fracture of the cranium and pressure of a piece of bone or of coagulated blood on the brain, are not indicative of the disturbed function of the particular cerebral portion thus irritated, because the shock radiates through and oppresses the entire mass, which, in its turn, compresses the nerves at the base of the cranium, and arrests or greatly disturbs the functions of the sensitive and motor organs. But let the pressure of the bony fragment be withdrawn by suitable means, and time allowed for the engorgement and turgescence of the brain to subside, and then the loss of mental faculty consequent on the alteration or destruction of the part primarily wounded, will show us clearly its office in health.

In addition to the other means of investigating function, by noting the effects of primitive deficiency of structure, and secondary alterations by disease, physiologists have had recourse to vivisection or direct and sudden ablation of parts, either by the knife or cauterization. Plausible, at first view, as this last method may appear,

it is liable to many fallacies, the chief of which consists in the general sympathetic disturbance attendant on the local injury. The state of the animal at this time too closely resembles the first or acute pathological condition of the human subject, after accidental violence to a part, or its subjection to phlegmasia, for us to draw any safe inferences. He who should assert that the kidneys aid the stomach in its digestive function, because this last is impeded, in nephritis, would not risk more of conjectural deduction than many have done in their conclusions respecting the subjection of muscular movements to the cerebellum, on account of the irregular locomotive efforts of an animal, after this part of its encephalon had been wounded by cutting away horizontal slices. That our scepticism of the value of most of the vivisecting experiments is justifiable and salutary, we have adequate proof in the discordant and contradictory opinions of those physiologists who habitually and confidently appeal to them as decisive authority. Nor can we help, in the instance of the study of the functions of the brain, contrasting these discrepancies with the general harmony, if not complete uniformity of results from comparative anatomy, fœtal growth, gradual development with increase of age, and changes induced by slow disease.

We must not, however, as already intimated, rest satisfied with a bare knowledge of the functional exercises of which an organ is capable. We are required to investigate the various modifications to which it is subjected, in virtue of impressions made on other and remote organs. This is the most interesting department of physiology to the physician, that by which the principles of hygiene are sagely applied, and rendered subservient to pathology and therapeutics. It is one moreover, in which the author of the present work has displayed much ingenuity, and patient and methodical research. Though the text had been given by others, for him was reserved the signal merit of illustrating by copious commentaries, and making the practical application of the close union between the physical and moral nature of man; and of explaining how the external world often takes its colouring from the nature of the internal or visceral sensations of the individual at the time. He has not committed the error of Bichat in supposing the passions to have their seat in the nervous system of organic life, or that prominent portion of it, the epigastric centre. But, whilst he justly regards the brain as the seat both of intellect and the affective movements, and the centre of all our relations with the objects by which we are surrounded, he traces, in strongly marked characters, a multi-

plied series of actions compounded of cerebral guidance and visceral stimulations. In his extreme desire to elucidate this part of his subject, he has perhaps exposed himself to a charge of repetitions of argument and redundancies of style; and the critic might advise remodelling and curtailment. Notwithstanding these blemishes, we cannot, after all, avoid acknowledging that our knowledge of these somewhat abstruse connexions between the functions of relation and those of nutrition, is greatly enlarged by the manner in which the author places before our view the two internal mucous membranes, pulmonary and gastro-intestinal, as surfaces of relation, in common with the cutaneous expansion and the senses, so called. To these he has likewise added the mucous surfaces of the bladder and of the organs of generation in both sexes. The acts of the individual are then, setting out from these data, a result compounded of the innate energy and activity of the cerebral functions, the intensity of stimulation of the external senses, and the particular condition, at the time, of the internal and sensitive mucous surfaces. In the passions of love, jealousy, anger, and grief, we have admirable examples of these compound movements: nor are the more purely intellectual processes exempt from similar though less energetic visceral modifications. One conclusion is irresistibly forced on us by the reasonings of the author; that philosophers must always be, and ever have been, utterly incompetent to an analysis of the moral and intellectual faculties of man, without a previous qualification for the task by a knowledge of physiology.

The first part of this work is mainly devoted to an examination of the relations which the brain sustains with the senses, both external and internal, and the apparatus of voluntary movements. In the second part of the volume, the author begins by a description of the great sympathetic or intercostal nerve, the connecting chain of the viscera, which bears the same relation to nutritive or organic life that the brain and its dependencies has to animal life, or the functions of relation. Very different from the cerebral centre, which is of ulterior formation in the new being, the sympathetic appears contemporaneously with the first rudiments of the viscera, continues to be increased with their growth, and its junction with the spinal cord is complete only after having obtained its full development. Taking this fact in embryogeny in connexion with the arrangement of the nervous system in some of the inferior classes

of animals, and in vegetables, both of which are destitute of an encephalo-spinal axis and corresponding nerves, but are simply supplied, the former with ganglia united by filaments, the latter by corpuscles or globules in juxta-position, but not in corded form, we are fully justified in the belief that the sympathetic nerve presides over, or is the immediate material agent of circulation, nutrition, and secretion and of the assimilating functions in general; and that it alone is fully competent to produce the necessary innervation for their full performance. The instances of fœtuses born with all their thoracic and abdominal viscera entire, although both brain and spinal marrow were wanting, and of the mollusca already adverted to, which have no encephalo-spinal axis, are additionally corroborative proofs of the correctness of this position. Consisting, as the sympathetic does, of numerous ganglia joined together by filaments in a longitudinal course, and of plexuses intimately interwoven with each other, and from which proceed twigs to envelop, as in a kind of net-work or sheath, the arterial and capillary vessels which supply the mucous membranes and their glands and the heart itself, we can readily understand how this nerve becomes a bond of union among all the viscera of nutrition or of organic life, and hence, also, how irritation of one viscus is transmitted to, and participated in by the others. Its sensibility being of a very low grade, the internal changes wrought by assimilation, are scarcely felt in a healthy state of the animal economy; nor would the abnormal alterations be made sensible but for the interweaving of the nerves of the encephalo-spinal axis with the sympathetic, in the cardiac, pulmonic, solar, and hypogastric plexuses. Here we are taught a difference between the internal and the external surfaces of relation, that is, between the mucous and cutaneous membranes, in the former deriving its vessels from that division of the arterial system solely supplied by the sympathetic, whilst the latter receives abundant ramifications from the nerves of animal life or of the encephalo-spinal axis. The sensibility of the mucous is, in consequence, much less than that of the cutaneous tissue, and pain is not in the first, as we constantly find it in the second, a sentinel prompt to apprize us of deviations from the normal state, such as irritation, congestion, and disorganizing inflammation. Whenever disease in the viscera is indicated by pain and disturbance in the cerebral functions and voluntary muscular apparatus, the symptoms are revealed to us entirely by the medium of the pneumo-

gastric and the lower spinal-nerves interwoven with the sympathetic.

We now discover that the functions of the mucous membranes are of a two-fold nature—first, as internal senses, they are, except the portion lining the jejunum and part of the ileon, in relation with the brain, and modify the operations of the intellect and the passions, as already adverted to; next, as surfaces on which are performed the processes of nutritive absorption and depuration, they are in the domain of the sympathetic nerve; and according to the number and variety of the stimuli or modifying agents applied to them will be their influence over the series of internal movements, which consist in the fixation of new matters in the organs, and the elimination from them of old. What we see, as of uniform and general occurrence in the nervous system of animal, holds good in that of organic life: viz. that the vivacity and extent of impressions, and the readiness of their transmission are proportionate to the expansion of the nervous tissue; and that the peculiar properties and functions of a nerve are rarely if at all evinced until thus expanded. The mucous, especially the digestive mucous surface, presents this condition in the greatest latitude for the sympathetic, and we may very properly regard it, with the author, as the surface whence impressions are conveyed to all the plexuses by which the assimilating organs are so liberally supplied and intimately linked together. The innervation through the nerves of the encephalo-spinal axis is prompt, but generally in a longitudinal direction and in a limited track, whereas, though slower in the sympathetic, it takes place in all directions, owing to the numerous anastomoses between the different ganglia and plexuses.

Enlightened by these anatomical and physiological data, we are prepared to appreciate the effects of abnormal digestion, first, on the brain, and through it on the organs of motion and sensation, in the phenomena of mental excitement, impatience and anger, muscular weariness, pain and intolerance of the accustomed stimuli from the class of the circumfusa; secondly, on the heart and lungs, and the glands subservient to digestion, as the parotid, the liver and the pancreas, and on the mesenteric glands, together with the kidneys, and the organs of generation. The first series of effects are recognizable by pain, restlessness and general uneasiness—the latter are usually more obscure, and are often only indicated by the altered nature of the secretions and by imperfect depurations. In derangements of the abdominal viscera, the stimulations conveyed to the

brain through the filaments uniting the ganglia with the spinal cord, or by the anastomosing branches of the pneumo-gastric, give rise to a crowd of confused sensations, constituting hysteria, hypochondriasis and melancholy, or in the more acute states, muttering delirium, subsultus tendinum and coma.

These distinctions, which are legitimately deduced from anatomy and the physiology of observation, are of the highest moment to the pathologist and physician. They must be constantly held in remembrance by the reader, if he would obtain a clear conception of the author's reasoning in this work, and shall we add, of the nature of disease. Once master of this key, he will find opened to distinct view all that would otherwise be abstruse and concealed in the Chapters on the Sympathetic Nerve, Abnormal Assimilation, Depuration, Exhalation, and Secretion. We can by it easily understand how abundant alimentation, by stimulating the digestive mucous surface, that on which the sympathetic is so largely expanded, will be followed by rapid absorption, and consequent plethora, and copious deposition, and nutrition, going on to polysarcia—in fine, increased activity of all the nutritive viscera. If this state be kept up, the secretors and depurating organs becoming overtasked by the mucous stimulation, will pour out an increased quantity of fluids from the various emunctories, as of sweat, urine, and pulmonary exhalation—in other words, irritation at one side of the expansion of the sympathetic is promptly responded to by the others. Gastro-enteritic irritation, whether from the abuse of food or excess in stimulating drinks, or medicinal agents, is the signal for hepatic, mesenteric, glandular, and renal disorders, associated with derangements of the pulmonary organs. Sensation to the extent of producing pain is not a necessary accompaniment of these phenomena. It may or may not be co-existent with them, according to the extent of the sympathies of the functions of relation. Occasionally, indeed, when the simple super-excitement of the digestive surface is succeeded by phlogosis ending in disorganization, we find associated with violent depuratory and secretory efforts of the viscera alarming pain and disease in the brain and senses: but at other times, although the lungs are overtasked to the discharge of vapour and carbonic acid, and the kidneys to that of urine, turbid, black, and even bloody, whilst the other mucous surfaces are in a state of the most disorganizing excitement, as in cholera or yellow fever, there is often no complaint uttered—no pain felt—no irregularity in the cerebral system; and in cases of the last mentioned disease,

even the strength of the muscular apparatus is but slightly if at all diminished. So, also, in the chronic diseases of the assimilating organs going on to marasmus, and accompanied by a slow fever, the mind retains its wonted energies, and no complaint is made, except of occasional lassitude. These facts duly weighed and arranged must give us an improved symptomatology, and incite us to a still more thorough investigation of the morbid changes in the internal viscera. Are we not in the too habitual practice of estimating their diseases by the sympathies of the organs of relation, and of making the presumed condition of the latter the measure of our treatment of the former; as when languor and disinclination to muscular movements are attempted to be removed by alimentary and medicinal stimuli to the digestive viscera, already in a state of commotion and suspended function from excessive irritation?

That we have not overrated the influence exerted by the first acts of the digestive process over all the subsequent ones of assimilation ending in the deposit of nutritive matter in an organ, will appear still more evident from some additional arguments which we now offer. Repeating after Hippocrates, *ventriculus sicut humus*, we may be allowed to compare the more simple yet distinctly marked organization of vegetables with that of animals, and regard the soil as supplying to the former what the matters in the stomach do to the latter, and the bibulous and spongy radicles of the root as similar to the absorbents of the mucous surface. Now we know, as phenomena coming immediately under the cognizance of the senses, that the rise of the sap in a plant, its elaboration into various new matters, gummy and resinous, and the growth of buds, efflorescence and fructification are directly dependent on the preliminary process of absorption by the spongy terminations of the root. Alter the regularity of this function, apply acrid fluids to the root, or surround it with compost of too rich a nature, and the plant becomes unhealthy, its leaves lose their verdure, the bark its smoothness and firmness, the secretions of gum are arrested, and fructification destroyed, or the fruit is small, shrunk, and ill-flavoured. The vegetable physiologist may perhaps add, that the integrity and healthy state of the leaves are likewise necessary to the vitality of the plant. It is on the foliated structure that the stimulus of light, heat, and electricity chiefly act, by keeping up a properly balanced exhalation and absorption of aerial matters on its expanded surface. Here we find the same function performed by the leaves for vegetables, which the lungs fulfil for animals: and whilst we admit that

the respiratory process is capable of modifying the nutritive absorbent apparatus in both, viz. sap-vessels and lacteals, we are still bound to believe in the paramount influence of the digestive spongy radicles and mucous surfaces, respectively, over the entire corresponding organized bodies of which they constitute so important a part.

The pulmonary mucous tissue performs very important offices in the animal economy. Through it does the oxygen of the atmosphere effect that change in the nature of the blood so essential to the vitality of all the organs,—by it is accomplished that depurating discharge of carbonic acid and vapour, the retention of which would prove so deleterious. This surface, capable of being so variously impressed by air of different degrees of purity and temperature, and by deleterious gases and vapours, must of course have multiplied relations with the other surfaces and organs of the body; and accordingly the heart, brain, skin, and stomach are found to sympathize with its irritations, as we see in catarrh, bronchitis, asthma, and the oppressed respiration in close and hot apartments. Its relations, as in the case of the digestive mucous membrane, are of a double nature—first, with the brain, by means of the pneumogastric nerve—and secondly, with the heart and abdominal viscera, through the intervention of the sympathetic.

Ought we, after this view of the structure, functions and connexions of the pulmonary and gastro-intestinal mucous membranes, to be surprised at the emphasis with which the author of this work descants on their pathological bearings. They are, especially the last, the most frequently offended of all the parts of the human body by various stimulation, often as abrupt as it is violent: and they propagate more diffusively and profoundly their irritations to other and remote organs, as well of nutrition as of relation. The reader cannot desire a more felicitous application to practical medicine of these principles than is found in the chapter on the Depurations. The succession of symptoms after the introduction of a noxious substance into the stomach is there so naturally described, and clearly explained, that we find it impossible not to recognize in them a picture of the malignant and pestilential fevers of authors, and to see in the hurried secretions consequent on the diffused irritation throughout all the assimilating viscera, a counterpart of our own perturbating treatment by the use of emetics, cathartic, diuretic, and diaphoretic remedies. It is not always required that a foreign body should be introduced into the digestive passages, in order to give rise to the above series of eliminatory actions. A

strong stimulation of the principal organ of digestion, the centre of the chief cords of the great sympathetic, excites a succession of irritative movements, which, if not arrested by too powerful a gastro-cerebral congestion, will finally terminate in an evacuating process of the eliminators, and frequently of the secreting organs which perform the part of auxiliaries to them. It is thus that a paroxysm of intermittent fever terminates in sweating, and that moderate gastritis ends in evacuations of every kind. Have we not in all these circumstances an explanation of the importance attached to crises in fevers, and of the rigid attention with which they were observed by the older writers who practised in warm southern climates, in which gastro-enterites constitute the larger number of diseases. When the rules of hygiene are neglected, and the laws of sound physiology broken by perpetual stimulation of the gastric surface, we can easily conceive how the continued eliminatory struggle of the skin and kidneys should so enfeeble their functions as to give rise to chronic cutaneous and renal affections. The almost uniformly morbid appearance of the tongue in these cases added to other symptoms of chronic gastritis would seem at once to indicate the etiology of the malady, and the means of relief: nor have all the experimental trials of conjectural medicine advanced us as far as these simple guides furnished by physiology. By the former we have been led to the use of irritant after irritant, with a view to obtaining certain antilithic and specific effects, and after all have settled down into the belief of what the latter would have at once pointed out, viz.: that the alleviation and cure of the morbid secretions is best obtained by a removal of the primary and central gastric irritation. For this purpose the simplest demulcent drinks and a milk diet will be found more efficient than all the heroicals of the materia medica. If we were allowed to reason *à priori* on the author's views, as exhibited throughout this work, we should be tempted at once to regard them as unquestionably correct, because, while appealing to nature, they yield the strongest support to sound morality. No health for the sensualist—no permanently pleasurable emotions for him who passes the bounds of moderation in the indulgence of his appetites, are warning monitions of constant recurrence in this volume.

A review of what has been said, will, we believe, justify the following propositions, which are so many applications of physiology to pathology. 1. The principal changes in the intimate structure of an organ, constituting the secretory and nutritive deposits, take

place in the cells or areola of the tissues, and the office of the vessels, both red and white, is to convey the necessary materials, and carry back into the general circulation what is effete or useless. 2. The modifications in the state of the functions, both of nutrition and relation, are effected by impressions on surfaces, consisting of a cellulo-nervous expansion. 3. Most diseases are the consequences of irritation on one surface, transmitted to various others. 4. Neither the activity of function, nor proneness to, or intensity of disease, on a membranous surface, can be measured by the size and number of the vessels, and nerves going to it; but must be estimated by a careful observation of the phenomena arising out of its relations with the various modifiers applied to it, or by the irritation received from another membrane with which it sympathizes. 5. The same laws of transmission from surface to surface, which govern diseases, regulate the operation of our therapeutical means. 6. There is, properly speaking, no general disease of the nerves or blood-vessels, but the commotion experienced through the vascular and nervous systems is purely secondary, symptomatic, and of minor importance—being in all cases, except of traumatic lesions or abscesses, the consequence of membranous irritation, or of a morbid condition of some of the expanded ramifications of the nervous tree, and disappearing when these latter are removed. 7. The muscles are merely instruments for facilitating assimilation in organic, and gratifying the brain and sensitive surfaces in animal life. They are, except in as far as their lining membranes and investing aponeurosis are concerned, strangers to the characteristic and decisive results of disease, which runs its course without materially influencing or being influenced by them. 8. The masses forming the brain and spinal marrow are, in like manner, alien to most of the important phenomena of function, performed by their expanded surfaces: they serve as nutritive supports, and commissures of union for these latter, on which primarily, or through the intervention of their investing membranes, are displayed the principal actions in health and changes in disease. 9. The functions of the vascular, nervous, and muscular systems, though instrumental to the series of actions constituting life, and especially of those important ones taking place on the membranes, are not identical with them, nor can the laws of the circulation, or of contractility, or of sensibility be brought to explain the properties of these membranes, or of the part which they perform in either health or disease.—They are a compound structure invested with new properties, the nature of

which cannot be predicated of that of any, or all of its elementary tissues: they must be studied in themselves, and with an attention to their own peculiar laws and sympathies.

A glance at the number of diseases in which the cutaneous and mucous surfaces are primarily and chiefly affected, and on the sustained irritation of which depends a crowd of alarming symptoms, will suffice to show that these propositions are not laid down without due advisement. On the pulmonary mucous membrane we have catarrh, bronchitis, laryngitis, tracheitis, coryza, and the hemorrhages designated by the terms epistaxis and hæmoptysis: on that of the digestive passages we meet with a great variety of inflammatory affections and hemorrhages; whilst the more numerous and troublesome disorders of the genital and urinary organs, in both sexes, have their seat in the lining mucous membrane. The cutaneo-mucous diseases give us all the devastating exanthematous affections, such as measles, scarlet fever, and small-pox. Fevers exhaust their malignant power on the membranes lining and investing the viscera. Pleurisy, peritonitis, and arachnitis, among the most formidable maladies of the three cavities, are inflammations of serous investing membranes. Rheumatism and gout chiefly interest the digestive mucous tissue and the aponeurotic expansion of the fibrous. Again, it may be averred, that in all these, and many other membranous diseases, there is, for the most part, immunity of the muscular and nervous masses, and of the parenchyma of the viscera from any notable change, and that there is no uniformity in the measure of the disturbanee of the vascular and nervous systems, nor safe inference to be drawn of the extent and violence of the membranous alterations and march of the disease from such disturbance.

It is by pursuing this course of faithful observation, that we may hope to acquire a knowledge of the true principles of physiological pathology, which, originating with Bichat, in his work on the Membranes, have been so fully extended and happily diversified by the author of the *Phlegmasies Chroniques*, and *Examen des Doctrines Medicales*, in the present treatise.

In reference to the present edition, we have only a very few remarks to offer. The text has been carefully compared with the original, and a few errors that had crept into the two preceding editions, have been corrected. The language throughout has been polished as effectually as could be safely done without impairing the sense of the author. Nor are these the only improvements that have been made in the present republication of the work. Many

additions required for the purpose of obviating several omissions of the author, or of correcting some views which we regard as insufficiently supported, if not erroneous, have been made, and will be found contained in an appendix. We have preferred placing the greater part of the additional matter at the end of the volume, rather than at the foot of the page, owing to the extent of some of the notes. We hope our readers will approve of the plan, and will concede that our efforts on the present occasion have not been devoid of utility.

A

Treatise on Physiology

APPLIED TO

PATHOLOGY.

CHAPTER I.

PRELIMINARY OBSERVATIONS.

Physiology is the science of life, and is applied to vegetables and animals, whether healthy or diseased. Our intention, in the present work, is to apply it to man in both these conditions; because, the functions in health are often elucidated by those observed in disease, and their lesions in the latter state, are only modifications of their condition in the former.

Physiology presents to our view an assemblage of mechanical and vital phenomena. We shall pay more particular attention to the latter, as furnishing more data to pathology than the former, which, however, will not be overlooked, when they appear to contribute to the same end.

Idea of Man.

Man is an organized being, enjoying, in common with all that lives, the faculty of developing and preserving himself during a certain space of time. These ends he accomplishes, first, by appropriating to himself, and subjecting to the laws by which he is governed, a certain proportion of materials which he derives from the other

bodies of nature; secondly, by rejecting all that he has taken beyond his natural wants, and which, having served his purposes, can no longer be of use.

In common with all perfect animals, man enjoys the faculty of recognising at a certain distance those things which are necessary for the maintenance of his functions; of searching for nutritive materials, and of depositing them in a central cavity, where they receive a preliminary assimilation, and whence one portion penetrates into the interior of his tissues, whilst the other is rejected as superfluous. Plants and zoophytes select their nourishment from among those bodies that are within their reach; but do not move in order to search for them, nor deposit them in a central cavity.

Man, also, in common with other animals, is formed of a matter which we shall denominate *animal*, and which presents itself under a certain number of forms convertible into each other: these forms are *gelatin*, *albumen*, *fibrin:* they possess the property, during their spontaneous decomposition, of affecting the olfactory sense in a peculiar manner. There are other forms of matter which animals present in their immediate materials; such as fat, the oils, mucus, and milk; but these are less essential, are found in the fluids only, and must all necessarily assume the forms of the three first, in order to become constituent parts of the tissues. Derangements of the assimilative faculty give rise also to other forms of animal matter; but these do not necessarily constitute part of the texture of the animal. Finally, with the three essential forms (gelatin, albu men, and fibrin) are found associated alkalies, acids, and certain salts, as the phosphate of lime, &c., most of which are discovered in numerous inorganic substances.

Man is distinguished from all other animated beings, first, by a peculiar form and attitude; secondly, by more multiplied relations with the bodies of nature; thirdly, and above all, by the power of reflection, or the faculty of perceiving his own relations, of observing himself whilst he observes every thing else, and of being impelled to this by a pleasure which appears to be independent of the gratification, at least immediate, of his physical wants: hence arise in him wants of a purely intellectual nature. The brute has relations with other objects only for the gratification of the wants of the organs, or in order to avoid the causes of destruction. Whenever it ceases to be stimulated by these motives, it remains in a state of immobility, or falls asleep; whilst man, on the con-

trary, after having provided for his physical wants, is still kept awake, and called to action by an irresistible desire of contemplating the spectacle of the universe, and of observing himself whilst occupied in that contemplation. It is this that constitutes his intellectual faculties; faculties which are peculiar to himself, and serve to distinguish him from all created beings.

We intend, in the present work, to study man in relation with all that is capable of producing an impression upon him, as well as in relation with himself; in the hope that we may thus discover the source of his diseases, and the means of preventing or curing them. Our study, therefore, is not that of the simple naturalist; but of the physician and naturalist combined,—of the man who endeavours to learn how he may best employ his life, with reference to the preservation, or re-establishment of his own health, and that of his fellow men.

We are not acquainted with any work specially directed towards the accomplishment of this double end. It was formerly the custom to study physical man, or, in other words to decompose him; and physiologists endeavoured to ascertain the action of his organs, with the view of determining how he lived in health, but rarely of learning how he became diseased, and maintained himself alive in spite of the morbid condition of his system. When they attempted to discover, in the study of physical man, some causes of disease, they sought them for the most part, in the defects of structure, in the division and displacement of parts, or in other physical derangements. In this sense alone, was the application of physiology to medicine made with any success. Authors, such as Baglivi, Rega, and some others, who endeavoured to discover the cause of disease in the simple play of the functions, independently of mechanical causes, never attained the object they had proposed to themselves. This want of success arose from the circumstance, that physiology, which at first was too mechanical, had subsequently become too metaphysical; and that pathology was still too superficial and abstruse. It was acknowledged, that physiology ought to serve as the basis of pathology; but this was confusedly perceived, and no one had succeeded in demonstrating it. Of all the authors on physiology, Bichat, in our opinion, is the only one who viewed this science in the most correct light; but he did not live sufficiently long to connect it completely with medicine. He pointed out the means of accomplishing this object; and, if he did not succeed himself,

it is because the phenomena of disease were presented, in authors, under an aspect totally dissimilar from the phenomena of health. This proposition, which I have already demonstrated in the *Examen des Doctrines*, will appear more evident from the approximations we shall have occasion to point out in the subsequent parts of this treatise.

I have read with extreme pleasure the article on the *Trisplanchnic* nerve, written by professor Lobstein, and contained in the *Dictionnaire des Sciences Médicales.* The author there considers the ganglionic nerves under a point of view which appears to me highly interesting, and approaches nearly to the idea I had already formed of them (*See Journal Universel des Sciences Médicales*, t. XII. 1818, and the *Examen des Doctrines*). Such essays abound in useful applications to practical medicine, and are worth many long treatises.

The mere study of the organs in relation with the causes which modify them, will always constitute, for physiologists, a fruitful, an inexhaustible source of new truths, from which we intend to draw. It is for having isolated symptoms, not merely from the organs, but also from the agents which modify the latter before, and during the whole course of, the disease, that physicians have created those entities, which, as we have already proved in the *Examen des Doctrines*, disfigure the science of medicine. The same error has been committed in physiology. Functions have been made too independent of those agents by which they are maintained; and to this circumstance it is owing that the change from the physiological to the pathological state, has not been hitherto completely discovered; or, in other words, that medical physiology has not been created.

The same error having hitherto existed in the method of studying and teaching both these sciences, or rather both these branches of the same science, it is evident that as soon as the one has assumed the right path, the other will follow.

It is not our intention, therefore, to present a history of the functions, viewed abstractly; but rather to give the history of the physical life of man. Our object is to ascertain the appearances that the animal matter of which he is composed assumes; to discover the organs that are formed from it,—the order in which these organs are presented to the action of external bodies,—the internal changes that are brought about, when those bodies we denominate modifiers (modificateurs) are placed in connexion with

the organs—the manner in which organs primarily modified, modify others ; and, if these latter operate on a third series, to ascertain the nature of their action, and when it will cease.

It is impossible that, in this study, we should not comprise that of the functions ; indeed, it even appears evident to me, that the history of the functions, when studied according to our method, must be more clear, and less lengthened by repetitions, than it can possibly be when investigated in any other way. On the other hand, as the functions will sometimes deviate from the rhythm which constitutes health, it naturally follows, that in our history of health, we must include that of the causes of disease, or the whole science of etiology.

CHAPTER II.

OF THE COMPOSITION OF THE HUMAN BODY.

The animal matter which enters into the composition of the human body, is distinguishable into, 1. the fixed animal matter, constituting the texture of the organs; 2. the movable animal matter, or the fluids. The former is arranged in such a way as to leave, in its interior, intervals or cavities of greater or less dimensions, in which the latter is kept in a state of perpetual motion. Besides having these cavities, the fixed animal matter is perforated on its external surfaces, and on such of its internal ones as are in relation with external bodies, by innumerable openings through which these bodies penetrate, and through which molecules that constituted, before, a part of the fixed or of the movable animal matter, escape.

Gelatin, albumen, and fibrin, are the principal forms of fixed animal matter. They exist in various proportions in the different organs and apparatus (appareils), and assume in the greater portion of the body the form of lines or filaments, more or less distinct from each other, and to which the name of *fibres* is applied.

By the word *organ* we are to understand a portion of animal matter, arranged in such a manner as to render it capable of per-

forming at least one of the acts which contribute, in a manifest degree, to the maintenance of life. Whenever several organs are united together, and associated for the accomplishment of one object, they constitute an *apparatus*. The common end of this association of organs, and of the acts depending upon it, is a function ; and the object as well as the common result of all the functions, is the maintenance of life.

The principal functions are confided to internal apparatus, denominated viscera. There exist also assemblages of organs, directed to the accomplishment of the same end, which are not contained exclusively in internal cavities, but which from them extend to various regions of the body. They are denominated indiscriminately *organic systems* or *apparatus ;* such for example as the vascular and nervous. The name of organic system is also applied to different tissues, which, without having among themselves any communications, resemble each other both in their structure and in their vital actions: thus, the diaphanous membranes, or sacs without openings, which cover the external surface of the viscera of the three cavities, in order to facilitate their movements, are designated collectively by the term *serous system.* It is in this sense likewise, that we apply the word *synovial system,* when we wish to represent the assemblage of those little sacs without openings, which facilitate the movements of the joints, and of the tendons in their sheaths. Bichat, from whom we have derived these divisions and the terms by which they are expressed, has classed together the ligaments which are destined to strengthen the joints, or suspend bones or other organs of considerable weight—the periosteum, a kind of membrane which is spread upon the bones, and which, wherever there is no insertion of tendons or ligaments, separates them from the other tissues—the more or less compact envelope of certain viscera, as the proper tissue of the spleen, that of the kidneys, that which contains the apparatus of the eye and gives it a spherical shape (the sclerotica) —the external envelope of the cavernous bodies; and to these organs he has applied the name of *fibrous system.* The bones, which are almost all in connexion with each other, are designated by the double term, *osseous system* or *apparatus ;* but the cartilages, and fibro-cartilages, are merely the appendages of this organic system. Finally, the muscles, or locomotive powers, have received the name of *muscular system* or *apparatus.* It would

appear, however, that the assemblage of these organs does not deserve the name of *apparatus*, and that this term should be restricted to the union of the muscles with the bones, cartilages, and ligaments; constituting together the *locomotive apparatus*.

In the early periods of life, all these organs, as regards the appearances of the matter of which they are composed, are homogeneous—nothing being distinguishable in them but a whitish albumino-gelatinous matter. In the progress of time, however, the three principal forms of animal matter become more distinctly marked, and each enters into the composition of a series of particular organs. The bones which constitute the basis of the edifice, present nothing but a mass of gelatin, combined with a saline substance (phosphate of lime). The cartilages, ligaments, and articular capsules, organs partaking of the character of the osseus parenchyma, and constituting the appendages, complements, and means of union of the various pieces composing the skeleton, are formed of gelatin combined with a smaller proportion of saline matter than that of the bones. The tendons also, a kind of appendages by which the muscles terminate, and which afford them a means of union with the bones, are composed only of gelatin. The same may be said of the aponeuroses which assume the form of membranes, destined either to contain the muscles submitted to the power of volition, or to afford them points of insertion; but the muscles, properly so called, present themselves to our observation as bundles of greater or less dimensions of red fibres; and these consist of that animal matter which was first denominated *gluten*, but, owing to the fibrous form which it constantly assumes, has received the name of *fibrin*. This matter is found in the muscular tissues,—as well in those which obey the power of the will, as in those which are independent of it and belong only to the viscera. The hollow cylinders which act as the conductors of the blood in its passage from the heart to the different organs, and are designated by the name of arteries, consist partly of gelatin, and partly of fibrin assuming a peculiar aspect; but those that carry the blood and lymph to the heart, present little else than gelatin, except perhaps in that part of their course where they are more voluminous, and nearest the heart; in which part, in some animals, fibrin is discovered.

Albumen, which derives its name from its resemblance to the white of an egg, is contained only in the brain and spinal marrow.

The whole mass of these organs, however, does not consist of it; since in them, as in other parts of the body, the small vessels, arterial or venous, are merely cylinders of gelatin: this matter constitutes also the tissue of the arachnoid, or of the membranous sac without opening, which lines the internal surface of the cranium and spinal canal, and is reflected over the medullary mass and its principal convolutions. Gelatin is also found in that portion of cellular tissue, which, under the name of pia mater, supports the vessels of the brain and spinal marrow. The nerves appear to be formed of gelatinous cylinders; and if albumen exists in them, it can only be in small proportion. Fibrin is said to have been discovered in the ganglions of the great sympathetic nerve. The skin and the internal membranes of the hollow organs are gelatinous, both in their proper tissue, and in the vessels and nervous extremities with which they so plentifully abound; nevertheless, as these nervous extremities appear to be in a pulpous state, we might be led to infer that there exists also some albumen, since it is found in the cerebral pulp. Chemists alone can render this subject certain by thoroughly separating these tissues from foreign matter, before submitting them to analysis. The cellular tissue, which is also called *laminated* or *areolar*, is the most simple form of organized animal matter, and appears to be the matrix of all the organs; that which is first formed, and in the midst of which all the others are developed. It supports, unites, isolates them, facilitates their movements, and appears in all their interstices. This tissue, which is so universally spread, and so important, is almost entirely composed of gelatin.

From the preceding observations, it is easy to perceive, that none of the parenchymatous viscera and secretory glands can be composed exclusively of one of the forms of animal matter. As all are furnished with blood-vessels or lymphatics, excretory ducts, nerves, and cellular tissue—and many of them in addition to these tissues possess a serous, muscular, and mucous membrane, it is evident that the three principal forms of this matter must necessarily be found in them.

These three forms predominate likewise in the fluids, or, in other words, in the free and circulating animal matter, known commonly under the name of *blood.* There exists, besides, a red colouring matter, which, in the greater number of animals, appears to be analogous to fibrin. We likewise find in the blood those

saline substances, or at least their elements, with which certain gelatinous tissues become incrusted : but what seems most worthy the attention of philosophers, in the history of the animal fluids, is that out of gelatin, albumen, and the fibrin of the blood, certain organs have the power of engendering new forms of animal matter. Thus the follicles of the skin produce a sort of fat or wax, somewhat analogous to that found in the interior of the bones, and in the adipose tissue. These liquids bear some analogy to vegetable oils. The follicles of the internal membranes of relation, form mucus, which appears to be nothing more than a modification of gelatin. It is in this way also that the kidneys fabricate urea; the liver, adipocire ; the breast, milk, &c.; without mentioning the more or less extraordinary forms, which animal matter can assume in inflamed parts and on suppurating surfaces. It is worthy of notice, that if all these varieties become the prey of some carnivorous animal, his digestive powers and the secondary assimilation soon convert them into gelatin, albumen, and fibrin. These three principal forms of animal matter are, therefore, those which chiefly merit our attention; more especially as to them alone nature has attached what physiologists have denominated *vital properties.*

CHAPTER III.

OF THE VITAL PROPERTIES OF THE TISSUES; VITAL POWER; VITAL LAWS.

The tissues are endowed with only one apparent property, which manifests itself by the condensation of the animal matter, at the moment it is placed in relation with an external body. If this property be examined in each fibre particularly, its operation will be found to consist in a simple shortening. Physiologists have called it *contractility.* (See appendix A.)

Whenever the fibre contracts in consequence of being touched by some agent, it is inferred that it has felt the presence of this agent ; from this is derived the term *sensibility.* Hence physiologists have attributed to the living fibre both sensibility and contractility. But, if the true meaning of these two words may be

thus expressed, "the fibre has contracted because it has been impelled to do so by a cause," it clearly follows that the first of these properties is a necessary consequence of the latter. For if the sensibility of the fibre is rendered evident only by its contraction, to say that the fibre is sensible, is to say that it has contracted. I see no reply to this argument. The truth was long since perceived; but it has been combatted by objections, which have prevented it from becoming universally admitted. These objections will be resolved in the course of the following observations.

Contractility exists in different proportions, in the different forms of animal matter. Fibrin possesses it in the most eminent degree; consequently, when nature wishes that an apparatus should execute extensive movements, she places in it a large proportion of this substance. Fibrin possesses naturally so large a share of contractility, at least in the condition in which it is found in the living body, that it tends continually to condensation, or, to the shortening of its fibres. For example, if the bones are softened or broken, the muscles become shorter; if we divide these latter in a transverse direction, each of their extremities retires towards the point of insertion: and, in respect to the hollow muscles, every one knows that they continually tend to obliterate their cavities, which are maintained only by foreign bodies interposed between their parietes.

This contractile property is inherent in fibrin, whether it constitutes a part of a muscle, or circulates in the interstices of the tissues; but in the latter state it can exercise the property only when it ceases to be subjected to the movement of the circulation. The state of life is, therefore, opposed to the complete condensation of the fibrin of the blood, as it is to that of the organized fibrin; and, undoubtedly, nature, or rather her author, employs this tendency for the accomplishment of important purposes, with which, however, we are not yet entirely acquainted. As soon as the blood is at rest, the molecules of the fibrin, which were before scattered in that fluid, approach each other and separate from the serosity, carrying along with them, in their interstices, a large quantity of gelatin, a less proportion of albumen, and all the colouring matter; it is this which constitutes the coagulum of the blood. The greater part of the albumen remains in the serous fluid, which the fibrin seems to express from its pores, during its condensation, in the manner of a sponge; as if this matter was a kind of dissolved flesh, containing the other fluids in its interstices, in the same way that it is itself

contained in those of the organized tissue. It is on this account that the name of *circulating flesh (chair coulante)* has been applied to the blood.

When separated from the body, the muscles do not lose their contractility, which continues to be developed by a number of mechanical and chemical agents, and still more powerfully by the influence of galvanism. It would be useless to endeavour to distinguish this property from that developed in the same tissues through the influence of life; it belongs essentially to that form of animal matter called *fibrin*, and can only be destroyed by its spontaneous or artificial decomposition.

The fibrin of the muscles, when considered in the state of life and organization, is often impelled to a degree of contraction greater than that which it manifests in its habitual state, and which necessarily depends upon its chemical composition. It is from this impulse that movements of a certain extent, the voice, and more especially locomotion, are produced. The nerves are the natural conductors of the influences determining this increase of muscular contraction. We shall speak of them in another place; but it is necessary to advert here to the fact, that the difference in the nerves acting upon the fibrin of the muscle, does not change, in the least degree, the nature of their contractility. Hence the words *animal contractility—sensible organic contractility*, do not express different properties; but can only serve, in the actual state of the science, to represent two circumstances, under which a property, that is invariably the same, is manifested. For example, let us suppose, that the visceral muscles were placed in relation with the nerves of the encephalic apparatus; in this case they would be endowed with animal contractility; whilst on the contrary, in the muscular fibres of a palsied limb, the organic contractility alone remains, because the limb is deprived of all communication with the cerebro-spinal nervous apparatus.

The form of animal matter, which next to fibrin manifests the greatest share of contractility, is gelatin; but, unlike what is perceived in fibrin, considerable differences are observed in it, according as it is more or less pure, in the various regions of the body. The cellular and laminated tissues are contractile, and even, like muscular fibres, constantly tend, though with much less energy, to condensation; but they return slowly to their former state. Whenever nature designs that the organic gelatin should be more

contractile than it commonly is, she combines with it a small portion of fibrin ; as we observe in those cylinders constituting the vascular apparatus. In some instances, however, they are, to a certain extent, endowed with this contractility without such aid. For example, I am not aware that fibrin has been discovered in the small veins, in the lymphatic vessels, and in numerous excretory ducts, the contraction of which is very evident ; nor is it said to exist in the skin, the contractility of which, during a chill, is often manifested with great promptness.

If the cellular filaments situated behind the peritoneum, and between its duplicatures, are susceptible of becoming shortened after being elongated, it is not the less certain, that this serous membrane, as well as that of the lungs, is enlarged and condensed, in order to conform itself to the volume of the viscera which it envelopes.

The gelatin of the ligaments and aponeuroses does not appear to possess extensibility or contractility ; which circumstance, however, depends less upon the crossed direction of the fibres of these tissues, than upon their combination with certain saline principles. The same remark is applicable to the tendons, which in youth retain for a long time some degree of contractility. In respect to the cartilages and bones, their contractile power becomes apparent, whenever, owing to a morbid state, they are deprived of the calcareous phosphate with which they are naturally incrusted.

Of all the forms of animal matter, albumen is that endowed with the least degree of contractility ; nevertheless, in a great number of instances, it is possible to show that it possesses some. The cerebral mass when raised mechanically, not only by the impulse of the blood sent with violence by the heart through all the encephalic vessels, but also by the effect of expiration, regains immediately its pristine state, by means of a movement of condensation directed from all parts towards its centre and basis. Such also is the direction of those lines of medullary matter which converge towards the mesocephalon (medulla oblongata). We moreover observe, in the encephalic apparatus, duplicatures and surfaces corresponding to each other, and the contact of which is rendered more easy by means of a serous membrane analogous to those that line the other visceral cavities. This is sufficient to prove to us, that within the encephalon movements take place of one part upon

another, and even changes of position to some extent, which can be explained only by supposing the organized albumen to be endowed with a degree of contractility peculiar to it.

We do not discover an extensive or rapid contractility to be manifested by the nervous cylinders denominated neurilema, and which are regarded as a continuation of the *meninges* or enveloping membranes of the brain; but we know, that these small tubes, which are joined together and contained in the same envelope, are formed of gelatin, which, like that contained in many other organs, is endowed, with a slow contractility, owing to its being combined with some inorganic substances. In respect to the almost or quite fluid matter which is discovered in the interior of each of the little nervous cylinders, I do not know whether it is constituted of a species of albumen analogous to that forming the intra-cephalic or spinal white lines, or of a peculiar form of fixed or free animal matter which has not hitherto been obtained separately or submitted to a special analysis; but I find that this internal portion of the nerves is, of all the tissues of the economy, that in which the fibrous form and contractility are with the greatest difficulty shown to exist. It appears to me, moreover, that we are reduced to the necessity of admitting both, purely by means of induction. However this may be, I do not believe, even if we were to discover a movement of condensation in those cylinders (hollow or not) which constitute the nerves, that this discovery would teach us what we wish to know respecting the mode of action of the nervous system. Every change occurring in the minute extremities of the fibres, vessels, &c., or, in other words, in the interior of the tissues, when their molecules, are placed in relation with those of the circulating fluids, is beyond the reach of our senses. We perceive contraction in the forms of animal matter which nature has intrusted with extensive movements; but it is absolutely necessary, that, anterior to these great condensations, there should be molecular movements, by which the former are determined. These latter movements, even when they occur in the interior of masses of fibrin, are entirely unknown to us; how could we pretend, therefore, to discover and to investigate the movements which take place in the interior of the encephalo-nervous apparatus; or, in other words, in that form of animal matter which excites all others to action?

From the preceding facts and observations it results, that, with the exception of the molecular movements, which, as we shall see, are placed within the domain of vital chemistry (*chimie vivante*),

all those that are discovered in organized animal matter, are reducible to the exercise of contractility. The latter is consequently a vital property. It may, perhaps, be objected that it is not purely vital, since it continues to be manifested, for some time, in those portions of organized matter that have been detached from the body; but this should be viewed as a vain subterfuge; for such a property has been given to this matter, in order that it may assist in the exercise and maintenance of the functions which contribute to the preservation of life. The name of *vital* must, therefore, still be applied to it. Let us now endeavour to determine what idea we should form of sensibility.

We have already seen that local sensibility, or, in other words, that which is considered purely and simply in the fibre contracting through the influence of a stimulating agent; that sensibility which is not transmitted to the mind (*moi*), and of which, consequently, we are not conscious; that sensibility, in a word, which Bichat has designated under the name of organic, was a mere abstraction of the mind—a conclusion drawn from the movement of contraction considered as the effect of the stimulating agent. It results from this, therefore, that we cannot, with propriety, regard it as a property of the tissues; but, can we refuse this name to the sensibility of which we are conscious, and in virtue of which we experience *pleasure* and *pain*?

Pleasure and pain doubtless indicate to us the movements that occur in our tissues, whenever these movements attain a certain degree of intensity; but from this are we to conclude that there exists a property inherent in matter, and so widely different from contractility, as necessarily to compel us to separate it from the latter? With a view of answering this question, let us offer an example. A man punctures his finger; the organic contractility of the part is increased, or, in other words, the movements are more rapid in it than before. If the nerves of the hand do not communicate with the brain, the individual is free from pain, whilst, on the contrary, pain is felt if this communication exist; are not the vital properties in both cases the same?—but let us proceed. Suppose that the pain resulting from the puncture has continued during the course of the day; at night a different state of the centre of relation supervenes; the patient falls asleep, and no longer feels the pain. Let me again ask whether the vital properties of the punctured part,—of the nerves through the medium of which this is made to communicate with the brain, or of the brain itself, are different

under these two circumstances? Every one I am convinced, will answer in the negative. Besides what should we think of a removeable vital property? Is it thus with regard to contractility? It never abandons the tissues endowed with it, unless they have lost their natural chemical composition. It is very evident, therefore, that sensibility is not a property that can be placed on a parallel with contractility.

If sensibility, even that of which we are conscious, is not of this nature, we can view it only as a condition, manifesting itself in a transient manner, in the organized animal matter; and it can be demonstrated that this condition is itself subordinate to the different states of contractility. Thus, organic contractility has been exalted in the punctured finger we have alluded to. If the brain be in a state of wakefulness, and in health, the nerves which establish the communication between the wound and that viscus, excite in it another increase of contractility, analogous to that produced in the wounded finger, and pain is felt. It is not risking too much to assert, that the brain experiences an increase of organic action or contractility. Experience proves this to be the fact; for if the pain be acute, the blood accumulates so abundantly in that viscus, that the face partakes of its congestion, and the excitement it experiences is spread very quickly to a number of nerves, producing similar changes in the structure and functions of the mobile tissues. Hence this influence will excite convulsions in the muscles—congestions of blood in the viscera and secretory organs—super-secretions—extravasations—hemorrhages, &c. &c.; phenomena depending essentially upon an increase of the contractility of the smaller vessels, or, in other words, of the organic contractility. It will perhaps be objected, that in those cases in which pain does not develope these phenomena, it does not produce an organic excitement in the brain. In answer to this, however, it may be observed, that pain invariably produces this effect; for even in those instances in which the patient would possess sufficient command of himself to avoid even a groan and not execute the most limited muscular movements, his features would be altered, the colour of his face would change; and assuredly these are external organic movements, the direct repetition, not of those occuring in the wounded finger, since they do not follow whenever the nerves of the hand no longer communicate with the brain, but of the organic movements excited by the pain in this viscus itself. But the stoic whom we thus re-

present as feigning to be insensible to bodily suffering, experiences moreover painful sensations in the epigastric region. Now these sensations indicate changes to have occurred in the circulation of the interior of the stomach, analogous to those observed upon the face; and indeed these changes are so real, that his digestive functions are affected—the secretion of the bile is deranged, &c.; phenomena which necessarily imply an alteration in the organic contractility of that viscus.

It will perhaps be maintained, as a farther objection to this opinion, that these disorders take plaçe in those instances only in which pain becomes violent, and that their absence during slight pain or pleasure is sufficient to show, that sensibility can be exercised without an increase in the contractility of the brain. I must confess, however, that I cannot conceive how a change should occur in the condition of the brain, capable of giving rise to pleasure or pain, and yet be unattended with organic movements, and with an afflux of fluids towards the modified part. I even maintain, that the derangements of contractility to which I have just alluded, are and can be nothing else than, the exaltation of these same changes of the brain, and that by increasing them they prove their existence, in the same way that the microscope, by augmenting all the dimensions of small objects, enables us to ascertain their form.

Let us now have recourse to another series of facts, calculated to determine the true character of sensibility. We have already seen that the property of the tissues could not have changed during sleep, which suspends the pain felt by a man in a wounded finger. Nevertheless, it is sufficiently known to all observers, that if this pain be very acute, and has had time to excite a local inflammation of some degree of intensity, the arm, during sleep, will preserve some heat, the pulse will also be accelerated, fever will supervene, and the brain will be so much excited, that the patient may even become affected with convulsive movements. The same occurs in a man who is kept in a state of sleep by the inflammation of an internal organ. Both these individuals at the instant they awake will complain of pain in the inflamed part; but they will both declare, that it completely disappears during sleep, although we have the proof that their brain is at the same time much excited. If the organic excitement of the part, therefore, does not cease to be repeated in the brain, although the pain disappears during sleep, we are naturally led to the conclusion, that pain is not an invariable

result of the excitement of the brain; or, in other words, that the organic action of the brain may be powerfully excited by a focus of excitement situated in some other part of the body, although there does not necessarily result a developement of sensibility. From all this, we may once more draw the conclusion, that sensibility cannot be regarded as an inseparable property of the tissues, and placed on a parallel with contractility.

In what manner, then, are we to view sensibility? As one of the results of the exercise of our functions—a result immaterial and incomprehensible in its nature, accompanied, in all instances, with an exaltation of contractility, but which is not inseparable from it. We must also view it as a violent condition of our economy, which must necessarily be intermittent, and the continuance of which, as we shall have occasion to demonstrate in our pathology, constitutes a true disease. As this phenomenon will again fix our attention, when we come to speak of the history of the relations, I shall abstain from further remarks upon it now, and proceed to the subject of the vital power.

The words *vital power (force vitale)* can offer to the mind only the idea of that power which presides over the formation, developement and preservation of the individual. Does this power reside solely in contractility, the only property of the tissues which we have acknowledged, among all those admitted by authors.

The power which presides over the formation, developement, and preservation of the body, is that which accomplishes the assimilation of nutritive substances—extracts from them gelatin, albumen, and fibrin—gives to these forms of animal matter the contractile property—regulates the form, consistence, volume, and duration of our organs, and re-establishes them in conditions requisite for the state of life and health, whenever, in consequence of the action of a morbid cause, they have deviated from these conditions. Let me now ask, whether contractility would be competent to produce all these effects? As well might we say, that contractility creates itself; since we have seen, that it essentially belongs to the form of animal matter which the vital power is alone capable of creating. Contractility, therefore, can only be viewed as one of the products of the vital power; as one of the means it employs to execute those movements which must co-operate for the maintenance of the functions.

The vital power or force, therefore, necessarily exists anteriorly

to the properties, or rather anteriorly to the fundamental property of the tissues. It first creates this property, and next employs it as an instrument for the purpose of procuring materials with which it works continually in the composition of the living body. Contractility and sensibility of relation, which, however, I have proved cannot be placed on a parallel, are consequently evident proofs of the existence of the vital power; but they do not constitute it.

In relation to the essence of this power, we are entirely ignorant; for it is a first cause; but it manifests itself to our senses by changes of form in matter. These changes consist in a special modification of the molecular affinities, which preside over the chemistry of animated bodies; in other words, it manifests itself by chemical phenomena—but of a chemistry proper to each of the living bodies. This vital chemistry (chimie vivante) is the most remote of the phenomena which strike our senses: doubtless it is not the vital power, properly speaking, but rather its first, its invisible, its immaterial instrument, with which we are made acquainted only by the exercise of our reasoning faculties; in a word, it is the instrument, by means of which the vital power creates, in its action on matter, the secondary instruments which are purely material, and perceptible to our senses, and in which we can discover what we denominate the *vital properties of tissue.* (B.) To me it appears evident, that we cannot extend further our researches into the vital power, without launching into the career of hypothesis.

The *vital laws* consist in a certain number of general phenomena, common to all the tissues, and which are discovered with so much constancy and regularity, in all animals, that we are led to regard them as laws inseparably connected with the state of life. They are, in some sort, general functions, or facts, constituting a part of the great function, which is life itself. I shall now notice those that appear to me most striking, and a knowledge of which is indispensably necessary, in order to study, with advantage, the history of living man.

I. The first circumstance which is constantly observed in our organization, is, that contractility is modified, or, in other words, is made to deviate in a greater or less degree from its actual mode, by all external bodies applied to the system. Are we to view these modifications as the result only of a pure and simple augmentation or diminution of the contraction or motion, whatever it may be, of our tissues? Be this as it may, there always exist several possi-

ble modes in the deviation of contractility, which cannot be pointed out in a general way, unless by saying that each modifying agent produces one peculiar to itself.

II. When the organic movements of contractility are accelerated in a portion of the living tissue, or of the fixed organic matter—in other words, when action or motion augments in a part, the fluids or movable organic matter are attracted towards it; from this has arisen the axiom, *ubi stimulus, ibi fluxus.* But if the contraction, although increased, becomes permanent, so that the fibre remains tense and shortened, without motion, or at least less agitated than before, this extraordinary attraction of free fluids does not take place. It even appears probable that a contrary state occurs, and that the fluids are repelled from the part in which this fixed and permanent contraction exists. This constitutes the state of *spasm.*

III. Whenever the organic movements of contractility are increased in a particular part of the system, and the fluids are attracted to that part, its density, and even volume increase, and it assumes dimensions that are determined by tissues designed for this object. These augmentations of volume constitute the *vital erections,* the degrees of which are as various as the form and vitality of the organs. All elongations and tumefactions which are not the effect of muscular actions, or of the forced retention of the fluids, are to be regarded as vital erections. Consequently there does not exist, as many authors have asserted, and as some physiologists still believe, any expansive power inherent in the elementary fibre. Vital erections are continually excited in the economy; since all prominent organic movements—all those which determine locomotion, must be numbered among them. These vital erections, when they have attained a certain degree of intensity, are denominated *irritation, super-irritation, or super-excitement.*

IV. In all vital erections there is an increase in the phenomena of vital chemistry; as, for example, in temperature, in secretion, when the part is endowed with this property, and in nutrition; phenomena which depend, in fact, on the transformation of the fluids, and imply the occurrence of changes, brought about by the vital power, in the molecular affinities.

Thus, to connect all that we have already remarked—contrac-

tility and the vital chemistry are the fundamental phenomena of the animal economy, and whenever they become more apparent in one part than in another, this local increase in their intensity receives the name of *vital erection.*

V. Vital erections subside after a longer or shorter space of time, and the vital phenomena are then generally less evident in the affected part, than before the developement of these erections; or else they are changed into a state of constriction, by which the fluids are repelled, in other words, into an *organic spasm;* or, finally, they attain the degree of inflammation and of sub-inflammation.

In all that we have hitherto said, the vital phenomena have been viewed only locally; we must now advance further.

VI. Whenever vital erections, irritations, excitements, and super-excitements, are developed in any part of the system, they cannot attain a certain degree of intensity without being transmitted to other parts: but here many differences are remarked, either in relation to the primary seat of the vital erection, or to the part to which it is transmitted. These differences depend on the peculiar nature of the different organs. In those that are not incrusted with calcareous phosphates, the vital erections make more rapid progress and attain sooner that degree of intensity, at which the transmission towards another point must take place, than in those in which this incrustation exists. In parts abounding with blood-vessels, and with nerves, the vital erections are still more rapid, and are much sooner transmitted. If we now examine the vital erections in relation to the part to which they are transmitted, we perceive that the tissues of the last series are the first affected, (the cause of which we shall presently see,) whilst, on the contrary, the tissues composing the two first series, are affected with extreme difficulty.

VII. The transmission of vital erections, or of irritations, is effected through the medium of the nervous tissue, which is specially destined to that use. Thus, in perfect animals, nervous cords, passing from the different organs to the cerebro-spinal mass, are invariably found to exist. In proportion, therefore, to the abundance with which an organ is supplied with these nerves, will be the rapidity with which the irritations developed in it are transmitted, either to the cerebral or spinal centres, or to other organs

equally well supplied with nervous cords; whilst, on the contrary, the irritations of organs, in which the number of these cords is limited, are invariably transmitted late, and with difficulty.

VIII. The transmitted irritation is of the same nature as the primary, and is always essentially the same phenomenon, whether examined in the part primarily affected, whether it be traced along the nerves that transmit it, or viewed even in their common centre; or, finally, whether examined in the organ in which these nerves have secondarily created a vital erection similar to the first. But some explanation is here necessary. When I maintain that the irritation is of the same nature, notwithstanding the difference existing in the tissues in which it manifests itself, or in the changes it produces in them, I wish to convey the idea, that it is invariably the result of the action of an agent, which has exaggerated, or rendered more prominent, and better marked, the phenomena that point out the state of life. The following may be adduced as proofs of the correctness of this assertion.

When the irritation, proceeding from a focus of vital erection, traverses the nerves, it increases their action and attracts the fluids into them; it produces the same effect in the encephalon and spinal marrow, as well as in the other tissues to which it has been reflected by these organs.

IX. The agents which develope the phenomena of vitality in our tissues, as well as in those of the greater number of warm-blooded animals, may be divided into two series. Those of the first exalt these phenomena in a direct manner; whilst those of the latter, first diminish them, or render them less apparent, after which they reappear with a greater degree of intensity than they manifested before their diminution. We are consequently compelled to recognise, in perfect animals, the existence of a law, by virtue of which the power presiding over life reacts against debilitating causes; it is this which constitutes *vital reaction.*

X. Caloric is the first and principal excitant of vitality; it is this agent that gives to the germ the faculty of appropriating to itself nutritive materials, and employing them for its developement. It continues to fulfil the same object during the whole course of life; whenever it is wanting, other stimulants no longer produce their accustomed effect, and death is the consequence. The properties of the tissues continue, it is true, to manifest themselves for some time; but they can no longer suffice to the maintenance of life.

In the end the chemistry of inorganic substances succeeds in destroying them; and, together with them, all the phenomena capable of recalling to the mind the idea of life disappear. The embryo is supplied with caloric from all bodies which possess more than itself, or, as in the case of the more perfect animals, from the mother. Afterwards life elaborates, in the same embryo, those organs which must procure it caloric, by deriving it, during the whole course of its existence, from the atmosphere.

XI. After caloric, comes a crowd of agents capable of exalting the phenomena of life. The principal are those which nature has destined to the maintenance of the functions, and more especially those that contribute to the nutrition of the animal. They act either immediately, or through the medium of the air or of light; and constant relations are established between them and the different organs on which they exert their action. At any rate, whatever may be the agent or the organ which receives its impression, the result of their relations invariably consists in excitement. I shall abstain at present from enumerating these agents, in order not to lose sight of the principal object of this treatise; but they shall be mentioned afterwards, whenever a knowledge of their action may furnish some data to physiology, pathology, and therapeutics.

XII. The causes of the diminution of the vital phenomena are either positive or negative. The principal among them is cold, which according to natural philosophers, is nothing more than the absence of caloric, and must, consequently, be classed among the negative causes. When cold acts upon the animal economy, the vital phenomena are diminished on the surface which is deprived of its caloric; and, if we study the first results of this impression, we are forced to divide animals, in relation to this effect, into two principal classes. Those that are cold-blooded do not react; they are benumbed or die: those in which the lungs are large, and the blood abundant, react, in a greater or less degree. Some, as for example, the hybernating animals, sleep until the return of heat; others experience pain in the part exposed to cold, and this pain becomes a stimulating agent, that reanimates all the vital phenomena. The reaction of the vital power against cold constitutes, therefore, a law of the animal economy. This reaction, however, has a limit, beyond which the non-hybernating animal, like the hybernating, becomes torpid; and, if the subtraction of the caloric continue, they both finally die.

XIII. Among the other causes of the diminution of the vital phenomena, we must place the subtraction of nutritive materials, as well as of the fluids, and of all the agents necessary for the exercise of the functions; and it will be constantly observed, that the power which regulates life, reacts, in like matter, against the debilitating modification resulting from their absence. This reaction, however, though less powerful than that which resists the impression of cold, is precisely of the same nature; as it always consists in an exaltation of the vital phenomena.

XIV. When the reaction of the vital power against debilitating causes cannot succeed in re-establishing vigour in the debilitated part, it is directed to other parts, and produces in these, notwithstanding the general diminution of the quantum of strength and of vitality, a super-excitement.

XV. The positive agents that occasion the diminution of the phenomena of life, are much less known than the negative. They have been denominated, by a particular sect of physicians, *contra-stimulants;* but I believe them less numerous than is commonly imagined. As we should not class among them such as act by substracting caloric from the living body, I am of opinion that they are reducible to a very small number. Brown thought that they could act only by a mode of excitement repugnant to the laws of life. His opinion deserves a serious discussion; but this must be deferred until we treat of pathology. It may be observed here, however, that mucilage is the most remarkable among these agents; but as in some cases it is employed by the vital power for the purposes of nutrition, I am inclined to believe that it is endowed with a peculiar mode of exciting property. The same remarks may be made in regard to water. Acids cannot be viewed in any other light than as excitants; since, when introduced into the system in their concentrated state, they produce a violent excitement. Be this, however, as it may, the vital power or force does not react against mucilage and water as energetically as it does against cold, when they are applied at the degree of temperature of the body; a condition which is necessary for preventing them from acting as excitants, or in order that the sedative effects may not be explained by the subtraction of caloric.

Having witnessed the relations existing between the vital and chemical laws, in the influence of caloric, and of all the foreign matters which are applied to the external and internal surfaces of

the body to serve the purposes of respiration and nutrition, we must examine these same vital laws in their relations with those denominated physical.

XVI. The physical laws are modified, in the living economy, by those of vitality. The attraction of masses is first presented to our observation: let us examine it as it affects the whole body, and each of its parts. This power tends to apply the mass of the living body to the surface of the earth; but by means of muscular contraction a part of its influence is annulled, and the animal is thereby endowed with the faculty of elevating itself wholly or in part; whence result walking and leaping. Whenever the action of the cerebral centre is suspended, as for example during sleep, the power of attraction resumes all its empire, and the body remains immovable upon the surface of the ground. If, by some muscular effort, the animal body has separated itself from that surface, it is once more attracted towards it as soon as this effort is exhausted. If the point of support of the living body fails it, the attraction of the centre of the earth draws the body immediately towards the point of its surface which is nearest to that centre, observing constantly a perpendicular line. As the living body is endowed with elasticity, the earth can repel it, when, by virtue of the power of attraction, they are brought in contact, with a certain degree of violence; but the effect of this percussion is finally annulled by the power of attraction, which always succeeds in bringing the body in apposition with the surface of the earth. Physical attraction overcomes, in all cases, the power of vital contractility.

XVII. The phenomena which result from the influence of attraction on the entire mass of the body, are also observable in each of its parts, when these are viewed in relation with each other; but as it is not necessary to dwell on this subject here, we shall proceed to notice the effects of attraction as it acts upon the movable animal matter, or fluids.

XVIII. Attraction tends continually to draw the fluids to the lowest region of the living body; but the contractility of the heart and vessels, offering a resistance to this power, traces for them, in the interior of these organs, a route they are compelled to follow: this constitutes another vital law. We have already noticed another by virtue of which the fluids, circulating in the interior of the vessels, are diverted from the direction which the contractility of these vessels tends to impart to them, in order to flow towards those

parts where irritation is developed; from which results what we have denominated *vital erection.*

When the contractility of the vessels diminishes, a less degree of resistance is offered to the power of attraction; and the fluids are drawn towards the lowest portion of the vascular system, in which they circulate. Hence arise those passive engorgements—those congestions from debility, which should be discriminated with accuracy from those which are the consequences of vital erections.

XIX. The atmosphere, in consequence of its weight, tends continually, from the pressure it exercises on the living body, to favour the efforts of attraction. Its action is first resisted by muscular power; hence locomotion is performed with much greater facility in a light atmosphere, as, for example, that of mountains, than in the heavy air of low countries. From the same reason, this pressure of the atmosphere upon the surface of the skin tends to occasion a condensation of the body, and to diminish its bulk; but this effect, as it regards the visceral cavities, is counterbalanced by that portion of the same atmosphere which penetrates into the lungs and digestive tube; and as the introduction of air in these cavities is the effect of muscular power, it follows that this latter contributes here also to the preservation of the volume of the body.

The contractility of the heart and blood-vessels, by maintaining the fulness of the circumference, contributes to the same end. So considerable, indeed, is this power, that when the ambient air loses a part of its weight, the former forces out upon the cutaneous surface a portion of the fluids that have reached the circumference. In this way it is that the skin is suddenly covered with sweat, whenever a man, after exciting his circulation by violent exercise in the open air, enters, without having rested, into a room, the atmosphere of which is lighter than that in which he was placed the instant before.

Consequently it is in virtue of a vital law, depending upon the exercise of contractility, that we are enabled to resist the pressure of the surrounding atmosphere. All these facts will find their application in our pathology and therapeutics.

XX. The imponderable fluids, known under the names of *electricity* and *galvanism*, and which are perhaps only modifications of general attraction, exercise, upon the living body, some influences that are modified by the power of life: this affords us an opportunity of pointing out new vital laws.

Electricity and galvanism manifest, upon the animal body, exciting effects, which are observed primarily in the nervous system, and secondarily in the tissues to which these nerves are distributed. These agents traverse the nerves, and determine an increase of contractility in the fibrin of the muscular, and in the gelatin of the vascular apparatuses. They occasion muscular contractions and vital erections, over which volition cannot exercise the least control. When applied slowly, and in a limited quantity, electricity increases the mobility and power of the muscles—accelerates the circulation to such a degree as to occasion frequency of pulse, and a considerable increase of caloric ; and revives, with so much energy, the power of absorption, that lymphatic engorgements are sometimes dissipated in the space of a few minutes. Hence the first vital law observed in relation to the effect of electricity, is a very manifest increase of contractility, and of its transmission from one part to another ; or, in other words, an increase of the sensibility of relation and that of sympathies, which, as we have already shown, are the results only of contractility.

XXI. When electricity acts with greater energy, and more suddenly, it produces, as in the case of galvanism, more marked effects, and gives rise to violent convulsions in the muscular system—to profuse extravasations, secretions, and excretions : it is in this way that galvanism excites hemorrhages, brings on a return of the menstrual discharge in women, and, when it acts in the direction of the digestive canal, occasions the sudden evacuation of the excrements. These modifications are merely an excess of those we have already noticed in the preceding paragraph.

XXII. The excitement of contractility, produced by galvanism and electricity, does not fail, when intense and often repeated, to exhaust this property ; under such circumstances, the body is languid—the power of attraction predominates over that of vitality, and, in general, nearly overpowers the vital chemistry. If this modification attain a certain degree of intensity, life is extinguished, and the spontaneous decomposition of the body takes place with much greater rapidity than after ordinary deaths. It is worthy of remark, that caloric acts in an analogous manner ; and that death occasioned by an excess of irritation, whatever may be the irritating agent, invariably disposes the body to a speedy decomposition. From these circumstances we are led to class galvanism and electricity among the most energetic excitants of the animal economy.

CHAPTER IV.

HISTORY OF THE FUNCTIONS OF RELATION.

General Observations.

Physiologists, of the present day, are all agreed in admitting in animals, two grand series of functions—the one destined to promote their relations with external bodies; the other consisting in those acts, which all concur to the maintenance and preservation of the individuals, and of the species. (C.) The first series is referred by them to the encephalo-spinal nervous apparatus, viewed in its centre, and in its sensitive and motive expansions; in other words, to the brain—to its prolongation occupying the spinal canal—to the nerves of what I denominate *external* senses, and also to those of the locomotive, respiratory, and vocal muscles, which are all attached to the skeleton. They assign the second, or functions of nutrition and reproduction, to the thoracic and abdominal viscera.

This division, which at first view seems so clear and satisfactory, offers, nevertheless, great difficulties when we endeavour to apply it to the study of physiology; for the phenomena of relation are far from being limited to the tissues, in which their domain has been placed by authors; and those of nutrition, commencing in the viscera, are continued in the nervous and locomotive apparatuses.

The same difficulties have arisen when physiologists have endeavoured to study each function in particular, since there is no apparatus that is not charged with the performance of several functions. Nevertheless, we should not be discouraged by such difficulties, depending, as they do, upon the nature of the subject itself. All the acts of vitality are united and linked together in the economy; consequently, we are frequently obliged to examine the same organ under several points of view; and, in some instances, are brought back again to the point whence we started, before we have succeeded in surveying the entire circle of phenomena presented by the state of life.

Hence arose the unconquerable difficulties encountered by the ingenious Bichat, in his attempts to draw a satisfactory line of demarcation, between the functions of relation, which he denomi-

nates *animal life*, and those of nutrition, which he calls *organic life*. Without pretending here to criticise this author, and those whom he has copied, or who have adopted him as their model, I shall proceed to examine the functions in the manner I may think best calculated to convey a correct idea of them. As our functions constitute an uninterrupted chain, from our relations with bodies placed at a distance from us, to the phenomena of composition or decomposition, which occur in the interior of our organs, it appears to me, that we should endeavour to examine all the links of that chain —commencing with the most apparent, and advancing by degrees to those that become imperceptible to our senses.

I shall, therefore, commence the history of our functions by noticing the relations which connect us with external bodies ; I shall trace those bodies as they approach and penetrate our own ; and study the influences they exercise on our organs, until I reach that point at which reasoning and induction can no longer afford me their assistance.

I shall commence by presenting a summary view of the relations, and next examine them in the different media through which nature procures them for us.

Summary View of the Relations.

I take man in a state of perfect organization, deferring the study of the developement of his organs until this subject becomes naturally linked to those I shall have already examined.

Placed in the midst of the universe, man lives and preserves himself by virtue only of his relations with external bodies. That he may derive from them the means of subsistence, it is absolutely necessary that he should be endowed with organs destined to correspond with them, in order to distinguish among these bodies such as are proper for him from those which are useless or hurtful—to appropriate to himself the former and reject the latter ; hence the cause of these relations, and the means of exercising them, are found within himself. The cause of his relations are his wants, whilst the means consist in the organs which present themselves first to the action of the external bodies.

The *wants* have their origin in the very exercise of life ; they are perceived, in man, by the centre of relation ; but if the external bodies by which they are to be gratified are not in actual rela-

tion with the external surface, and if the centre of perception is not as yet apprized of them, there results from these wants nothing but a vague sensation of uneasiness, which is difficult to define, but which induces in us a degree of agitation without any evident object. Such probably are the motions of the fœtus, especially when it approaches the period of its expulsion—such are doubtless the cries it utters after birth, and the irregular movements of its little limbs. We may moreover place in the same line, the uneasiness, the sighs, and emotions of young pubescents who have been brought up in entire ignorance of, and separated from, the objects capable of gratifying their first desires.

As soon as the external bodies necessary to the gratification of our wants are placed in relation with the external surface, the sense with which this latter is endowed gives information of their presence to the centre of perception: the latter immediately recognises them; the perception is conveyed back to them, and becomes clear in the animal which experiences the desire of appropriating them to itself. During the earliest periods of infancy, and in all instances where the nervous centre is not restrained by any other perception, the movements necessary to the gratification of this desire are commanded and executed without delay. Hence the new born infant instinctively directs his mouth towards the nipple, as soon as the breast of the mother is presented to him, or is even placed within his reach; nor is any interval allowed to exist between the perception of a want and the execution of those acts proper to gratify it, until consciousness *(moi)* is developed and sufficiently exercised, and the memory sufficiently stored with recollections to enable him to find motives for suspending the acts solicited by wants.

Another question now presents itself. What takes place in the perception of the wants, and in the act solicited and commanded for their gratification, likely to be evident to the senses of the observer? In order to answer this question, it is necessary to trace the impressions from the external senses to the interior of the viscera.

The acts which, in virtue of the impressions made on the external senses, are solicited by the wants, and commanded by the centre of relation, are invariably the consequence of the actual condition of these organs at the moment the impressions are made. Let us illustrate this statement by a few examples.

An aliment is presented to the sense of sight, hearing, or smell; if the stomach be in want of it, the perception is agreeable, and the desire of appropriating the aliment is developed with energy. If, on the contrary, the stomach be full or diseased, the perception is disagreeable; the aliment inspires a sensation of disgust, and the centre of perception determines, or tends to determine, actions proper for removing it. The same is found to be the case with the sensations which relate to the propagation of the species—with the impressions of heat and cold, and even with respiration; for we experience a reluctance to breathe a disagreeable and unwholesome air; whilst, on the contrary, the throax dilates amply, and with a sensation of pleasure, when we suddenly pass from a warm and heavy air, filled with injurious vapours, into a free, pure, and cool atmosphere. It is very certain, therefore, that the centre of perception judges of the impressions of external bodies only from their relations with the viscera which are interested in these impressions.

But let us proceed. In order that this judgment may take place, it is indispensably necessary, that the impression received by the external senses, and transmitted by the nerves to the centre of relation, should be immediately reflected, by this latter, to the viscera.

This mechanism is without doubt indispensably necessary; but we are met by another question: are the impressions reflected only to the viscera which they especially concern? Does the odour of the aliment affect the stomach alone? Is the sensation resulting from the sight and odour of the female, and from the sound of her voice, directed, by the centre of perception, to the genital organs alone? Reason rejects the admission of this unity of direction towards this or that organ; for it would lead to the supposition, that the impression is weighed and judged by the centre of perception at the instant it reaches the brain; whilst we have just proved, on the contrary, that it has no influence on it until after the viscera have responded. Nevertheless, this is merely an induction, and as I can offer more direct proofs of the correctness of my opinion, I shall not rest satisfied with it.

The impressions relative to our wants, which are received by the external senses, are reflected by the cerebral centre to all the viscera, and even traverse with the rapidity of lightning the whole extent of the nervous system. The following may be adduced

as proofs of this assertion. Let us suppose that a carnivorous animal, the wolf for example, is placed in a situation, from which he can discover at the same moment his female and a sheep. In this case he receives only the impression of the external form of these two animals ; but the judgment made by the brain is of two kinds —the sight of the female will excite the genital organs, whilst that of the sheep will awaken his appetite. If the want of food predominate, the animal will seize his prey in order to devour it—if, on the contrary, the want of coition be greater than the sensation of hunger, he will approach the female with the view of gratifying it. Hence the impression made on the sight of the wolf, has reached at the same time the digestive organs as well as those of generation. If it were objected, that the two impressions, although produced on the same sense, were, nevertheless, different, the one being excited by one animal and the other by another, I should answer, that their difference is only the result of the colour impressed upon them by the genital organs and by those of digestion. So true, indeed, is this, that were the wolf castrated, he would invariably neglect his female in order to seize the sheep. At any rate, the following example appears to be still more satisfactory ; since it consists in an impression precisely similar, which is judged by two animals differing in their viscera. Place a ewe between a wolf and a ram ; the one will approach her for the purpose of devouring her, and the other to cover her. The following fact is still more satisfactory. Bring together, and suddenly, two tigers of different sexes ; if it be not at the period of rut, (as always happens in our climate, where these animals never breed,) they will become furious, and, as was observed a few years ago in the Ménagerie of Paris, when attempts were made to excite the two large tigers of Bengal to the act of copulation, they will mangle each other ; and doubtless, had they met during the season of their love, and in their native climate, the acts excited by the impressions they received from each other would have been widely different.

But to conclude : since the same impressions give rise to acts different according to the condition of the viscera, we are led to the conclusion, that they are invariably reflected at the same time to all the viscera ; and that such among these as are more immediately interested in each impression, act most powerfully upon the mind, and determine the degree of the impression and the acts

which it will be necessary that the centre of relation should cause to be executed by the locomotive apparatus.

Between the demands that are made upon the centre of perception, by those viscera interested in the approximation or removal of bodies that have acted on the external surfaces of relation, and the acts, which, in consequence, the centre determines, or tends to determine, we meet with the phenomena of intellect. So long, indeed, as the animal allows no interval to exist between the perception of the want and the movements necessary for gratifying it, it manifests nothing but instinct. Consequently, instinct alone acts in animals of the lowest order: we hardly recognise any thing more, even in those endowed with the most perfect organization, at the moment of their birth; and man himself cannot be adduced as an exception to this rule. In proportion, however, as his brain enlarges, his consciousness (*moi*) is manifested—his intellect becomes developed; and, when it has attained its highest degree of perfection, the impressions relative to his wants no longer exert on him the same influence, as before. The acts solicited by the first wants, are finally modified in a manner peculiar to him; he experiences another series of wants, having apparently no connexion with those, the object of which is the maintenance of life; and yet the impressions produced by them, operate upon the nervous system in the same manner as those that are referable to instinct.

In maintaining that the impression is reflected from the brain to the viscera, it is evident, that for the purpose of conveying my meaning, I make use of a figurative expression. All I wish to convey is, that the irritative movements excited in the external senses by foreign bodies, are transmitted by the nerves to the brain, and thence to the viscera, in the direction of the nerves distributed to the latter: finally, that the movements which take place in the viscera, upon the reception of the impressions, are perceived by the centre of relation, and produce in it a sensation, from which results desire or aversion.

These movements, when considered in a purely physical point, of view, cannot be regarded otherwise than as a play of contractility, combined, as I have already shown, with an afflux of fluids. They are, therefore, true vital erections. Consequently, whenever the viscera make known a want, there is primarily a vital erec-

tion in them ; and next the same effect is produced in the brain, where the phenomena of perception are manifested. This erection is again repeated in the viscera, when they are consulted ; in consequence of this, the centre again experiences a new perception which is always the effect of a vital erection. Finally, it is by means of a vital erection that the brain acts upon the nerves of the muscles ; and a similar condition is developed in the muscles, when the nerves excite them to contraction.

Directed by the centre of perception, the muscles execute the movements necessary for the gratification of the wants. External bodies are brought in contact with the internal surface of the viscera; and from this moment a new series of relations is developed, which takes place between these and the centre of perception, and the physical effect of which is invariably a vital erection.

Although the erections which result from the relations existing between the centre of perception and the viscera touched by bodies recently introduced into them, are internal, they nevertheless exert an influence upon the manner in which the centre of perception judges of the impressions made by external bodies. Here the phenomena I have already cited, are again presented; for, if the stomach be full, the aliments offered to the external senses will produce on the cerebral centre an impression, which will be judged very differently from what it would be were this viscus empty; and the same remark is applicable to the other wants. We may consequently observe an uninterrupted circle of relations existing between ourselves and external bodies.

The vital erections that take place when the relations with external bodies are brought into action, are the phenomena with which the history of what may be denominated the *internal* or *organic* life must commence. Hence we may perceive, that it is impossible to give a satisfactory idea of it, without having first studied, in detail, all the relations. I shall, consequently, proceed with these details; presenting in succession to the attention of my readers, the external surfaces, by the aid of which we are placed in relation with foreign bodies.

CHAPTER V.

EXAMINATION OF THE EXTERNAL SURFACES OF RELATION, OR OF THE EXTERNAL SENSES.

Section I.—*Of the Skin.*

The skin is the most extensive of the sensitive surfaces; it is the first sense observed in animals; and among those of the lowest orders, it is even the only one. Viewed in its relations with the zoological scale, it constitutes the universal sense, in which all the others, are gradually marked out, and finally developed.

The skin presents to the observer two series of phenomena: the first relate to the connexions which, on the one part, exist with external bodies, and, on the other, with the centre of relation. The second belong to the organic functions. The skin manifests the former of these series of phenomena, by the modification of the nerves with which it is supplied;—it gives rise to the latter, by means of those agents which modify the contractility of its vascular system. In the former, therefore, it acts, as a sensitive organ; in the latter, as a secreting or exhaling organ. Although these two series of vital phenomena are intimately linked together, we shall, in this chapter, offer a complete developement only of the former; reserving the other, as much as possible, for the history of the internal or *organic* functions. I say as much as possible, for it will be difficult to study the results of the sensations of the skin, without discovering in them some modifications of vascular contractility.

As all these functions are equally the result of the structure of the skin, it is proper that I should succinctly describe it. The basis and principal tissue of this envelope consists of a fibrous network, composed of filaments, which leave between them spaces of greater or less extent, according to the part in which it is examined: this tissue has received the name of *Chorion*, or *Derma*. The filaments of which it is composed are continuous with the sub-cutaneous cellular tissue, or with aponeuroses and ligaments. The intervals existing between them afford a passage to arteries, veins, and lymphatic vessels—to nervous filaments, and to the cellular tissue; the whole of which, after having penetrated externally

through the derma, are finally expanded upon its external surface. When we examine this surface, we discover in it, first, a mucous net-work, which was at one time regarded as entirely fluid, and denominated a *mucous* body; but which, when discovered to be a true organic tissue, received the name of *reticular:* secondly, eminences which are designated by the name of papillæ. The reticular body and the papillæ are nothing more than the vasculo-nervous apparatus of the surface of the skin,—an apparatus which no anatomist has hitherto succeeded in dissecting. It is impossible, indeed, to isolate in this tissue a vein, or an artery; and the neurilema can no longer be detected: all we can see is, that the papillæ are endowed with a greater degree of consistence than the reticular or mucous body, in the midst of which they form, particularly in those regions of the skin where the sense of touch is most delicate, prominences, more or less apparent; whilst, in other parts, it is very difficult, and even impossible, to perceive them.

It is invariably observed, that those parts of the skin in which the papillæ are most numerous, are supplied with a greater quantity of nerves of relation; from this circumstance many have been led to imagine that the papillæ consisted of nothing more than nerves terminating in a kind of nervous pencils or tufts; but a more attentive examination enables us to discover in them so large a quantity of blood, that some authors have regarded them as purely vascular. This leads me to believe, that these papillæ are composed of a nervous substance intermixed with sanguineous capillary vessels; whilst the reticular body is a tissue more vascular than nervous, in which, together with blood, is found a considerable quantity of white fluids. It is from this tissue that the fluids of insensible and sensible perspiration are exhaled; the latter of which is, in all probability, nothing more than the former exhaled in too abundant a quantity to be transformed entirely into a vapour at the moment of its elimination. As respects the papillæ, it is certain that they are destined to the sense of touch.

In some parts of the skin, small follicles are discovered, which furnish a fatty, oily, and inflammable humour. In other parts it is impossible to ascertain their existence, although the oily matter is still secreted.

The hair has its origin under the skin, in small capsules, having the form of sacs, which some anatomists have regarded as the

secretory organs of the sebaceous or oily humour. The hair passes through the interstices, existing in the fibrous texture of the skin, and reaches the exterior by means of small apertures made in the epidermis. If the oily matter be formed in the small sacs which produce the hair, it reaches the surface of the skin, by gliding along the cylinder of the former. Finally, we discover, upon the surface of the skin, the epidermis, which constitutes its external covering. It consists of an inorganic tissue—a true secretion, which coagulates and hardens after its formation. It serves to protect the cutaneous surface from the action of external bodies, and to moderate the impressions produced by the touch, as without it they would almost always be very painful.

The epidermis is formed neither of gelatin, mucus, albumen, nor fibrin; it consists of a peculiar animal matter, analogous to the nails and to horn, and which, when removed, is regenerated like every other inorganic substance, unless the vascular apparatus of the cutaneous surface, by which alone it is produced, be destroyed.

The nails are nothing more than a product analogous to the epidermis, of which they constitute merely a modification appropriated for certain uses.

The more we read and meditate the works of those authors who have investigated the structure of the skin, the less certainty do we acquire on the subject of its intimate texture. Some have distinguished in it, 1. fleshy buds (*bourgeons charnus*), which are only vascular fasiciculi; 2. between these and the epidermis, a deeper whitish layer (*couche albide profonde*), consisting, according to them, of white vessels; 3. over this layer a dark coloured line resulting from small bodies that cover the summit of the buds, and which have been designated by the name of *gemmulæ;* 4. finally, just beneath the epidermis, a second colourless layer, consisting of serous vessels, and denominated by them superficial whitish layer (*couche albide superficielle*), which layer is thought to be charged with the function of serous exhalation.

Other anatomists admit in the skin: 1. the *derma;* 2. the *papillæ;* 3. the *epidermoid membrane* of the papillæ, which is the deep whitish layer of the preceding writers; 4. a *coloured layer;* 5. a *horny* layer, which corresponds to the superficial whitish layer; 6. and lastly, the *epidermis*.

Others again content themselves with establishing two divisions

in the skin: 1. the *derma,* which embraces all the organic elements of this membrane, between which it is impossible to establish any distinction; 2. the *epirdermis* or inorganic portion.

On this subject the reader may consult the additions with which professor Beclard has lately enriched the new edition of Bichat's *Anatomie Générale,* and from which I have extracted the preceding details. Be this as it may, I conclude, from these researches, what I have already advanced, that there exists on the surface of the skin a capillary tissue, which is vasculo-nervous, cannot be dissected, and the papillary portion of which, being the most plentifully supplied with nervous matter, is entrusted with the functions of touch, and the sympathies of relation; whilst all the rest is devoted to the various secretions and exhalations discovered on the cutaneous envelope. We must also admit the existence, in the skin, of the sebaceous follicles, and of the pilous capsules. I believe that, with these elements, we can sufficiently well explain the functions of the skin; I shall, consequently, offer an exposition of its relations.

The skin enables man to perceive the temperature of external bodies—the condition of their surface, which is either smooth polished, or rough—their form, of which it enables us to judge, by passing over their surfaces, and grasping them when not too voluminous—of their consistence, volume, &c. From these sensations clear ideas result, which furnish to the mind materials for judging of the external and physical qualities of bodies; but the skin does not decompose or analyse them, in order to convey to us an idea of their chemical properties, and enable us to foresee their effects on the system as nutritive materials: other senses are charged with this function; its object therefore is to bring us into correspondence with the masses of matter which come in contact with our body.

While the skin furnishes, to the centre of perception, materials calculated to enlarge the boundaries of our intellectual faculties, this membrane acts sometimes in the following way, on the viscera. The sensation caused by polished and elastic bodies, of a moderate degree of temperature, is agreeable; it constitutes a pleasure which is felt, not only on the cutaneous surface, but also in the principal departments of the nervous apparatus of relation. It is in this way, that touching the body of a female re-excites into activity the genital organs—accelerates the action of the heart, causes a sensation of voluptuousness in the epigastrium, and even

in the interior of the muscular tissue. Under these circumstances, organic phenomena associate themselves with those of relation. The seminal fluid is secreted in greater abundance—erection takes place, not only in the genital organs, but also in the mouth, which reacts on the salivary glands—the eyes become red and sparkling—the colour, secretion, and even sensibility of the skin (for we often experience a kind of chill), are modified.

Phenomena nearly similar are manifested during the effect of certain frictions, applied slowly, and always in the same direction, by the hand of another person. From these result a kind of relaxation of the brain—a sluggishness of thought—a tendency to sleep, and a languor of the muscular apparatus; the circulation becomes more regular—pain is mitigated or removed—the whole surface of the skin partakes of the modification of the portion touched, and a mild heat and more uniform temperature is established over the whole surface of the body. Such are often the effects produced by the touchings of the magnetisers, who derive from them their power of fascination, and the occasional real success they obtain in nervous irritations, occurring in sensible and delicate individuals. The tepid bath often produces effects nearly analogous to the preceding.

Whenever the skin is touched and rubbed a long time with rough bodies, it transmits painful sensations to the the centre of perception. The individual experiences a sort of aversion—a tendency to irascibility, and anger—a disposition to execute such movements as are necessary for repelling the irritating cause; and, in some instances even violent convulsions supervene. The touching of dry bodies covered over with small asperities, such, for example, as cork, gives rise, in many individuals, to a sensation of aversion, attended with chilliness.

Tickling developes a number of sensations more or less acute; an accelerated action of the heart, an involuntary agitation, and even real convulsions, which may suspend the functions of respiration and circulation, produce thoracic and encephalic congestions, and even death.

The phenomena of relation attached to the tactile functions of the skin are, therefore, of three kinds; those of the first relate to the intellect, those of the second to instinct, and those of the third are manifested in the distribution of the fluids, and in the disorder of the organs charged with the performance of the various secretions.

Thus we verify in this first relation of our body with external agents what has been said above,—that the sensations are not judged by the centre of perception alone and *a priori;* but after the latter has reflected them to the sensible parts of the system, and particularly to the viscera. If we desire to see, in the clearest manner the influence exercised by the viscera upon the determination of the centre of perception, and successively the triumph of the mind over the viscera, and of the viscera over the intellect, let us suppose a person endowed with lively sensibility, and subjected to the process of titillation. If it be practised at first feebly, the patient experiences an inclination to laugh and to escape from the person who tickles him ; but he retains the power of resisting, and when he is determined to do so, he will succeed. If the action be more powerful, he can no longer resist;—he becomes agitated—he laughs out, and, when the titillation is applied with greater violence, he flies into a passion, and struggles with great violence; finally, we are no more able to resist this singular sensation than the impulse, by which we are led, after suspending a long time the function of respiration, to dilate the thorax, in order to procure a supply of air.

The respiratory function—defecation—vomiting, &c. are, therefore not exclusively endowed with the privilege of overcoming the power of the will. The same effect is produced by every sensation carried to excess; and it is always the result of its very energetic repetition in the principal viscera. It is thus that titillation acts;—the sensation which it produces is conveyed to the brain, which reflects it to the epigastric centre; and it is the sensation which the brain perceives in this region, that compels it to command those hurried movements of which I have just given a sketch. This mechanism is proved in the following manner. If a person sensible to titillation be attacked with apoplexy, he no longer experiences the sensation in question. If the stomach be inflamed, he feels the sensation, but is neither inclined to laugh, nor struggle in order to avoid it. I have had many opportunities of noticing this fact, in my daily visits at the Val-de-Grace. The man attacked with gastritis, and whom I could touch without inconvenience at the first visit, often becomes ticklish the next day, when, by means of one application of leeches, the irritation of the stomach has disappeared: and if he experience a relapse he can again suffer his sides to be felt without feeling an inclination to laugh or to struggle. A slight attack of gastritis often produces the contrary effect.

The sensation of titillation may also be annulled by a point of irritation situated in another tissue—as for example by pneumonia. In this case the centre of perception, being attentive to another sensation, is not affected by the former. The same thing occurs in profound meditations and grief; while, on the contrary, if we enjoy a lively disposition, the effects of titillation are more acute than under ordinary circumstances. Certain exaltations of the sensibility of the abdominal viscera also increase this kind of susceptibility; such for example, as the hysterical state, which may produce laughter without the aid of any moral cause.

All these facts concur in proving, that stimulations exercised on the cutaneous sense, can act on the viscera only through the medium of the brain;—that the movements determined in the muscles of locomotion by the brain, are invariably the effects of the sensations which it perceives secondarily in the viscera;—finally, that the organic movements are in all instances influenced both by the sensation; and by the exercise of the muscular contractility.

All we have hitherto said in relation to the sensations of touch is applicable to those produced by the action of contusing, cutting, or tearing bodies; by that of burning—of excessive cold—of distension—of the twisting of ligamentous parts;—in a word, by pain, considered in a general manner, whatever may be the form it assumes. Pleasure is always the effect of the stimulation of a sensitive surface; but pain, independently of this cause, may be produced by others acting in the interior of our tissues, provided these be supplied with a sufficient quantity of nerves. Now, the pain is conveyed to the centre of relation, which, if not occupied by another perception, and if the part of the brain where it resides be not diseased, reflects it back to the viscera; and the brain acts in virtue of the secondary sensations it perceives in them. The following are the demonstrative proofs of this fact.

When the digestive organs are in a healthy condition, the pain occasioned in another part of the body, by the mechanical causes we have already enumerated, may be borne with great fortitude, if the will endeavours to moderate the violence of the acts which the sufferings tend to excite; but if the stomach be affected with inflammation, the pain is felt much more acutely. An intolerable sensation originates in the epigastrium, and gives rise to impatience, grief, anger, and fury; and, however strong may be the determination of the patient to remain tranquil, he yields in most instances

to the acuteness of these new sensations, and abandons himself to impetuous movements. It is in this way, that gastritis perverts the moral sense, transforming into an impatient, passionate, and furious being, one who was previously among the mildest, firmest, and most capable of enduring physical and moral sufferings. This, assuredly, could not occur, were not the sensations reflected to the viscera before being judged by the centre of perception. These preliminary positions will aid us in explaining the phenomena of relation which have their origin in the exercise of the other external senses.

Section II.—*Of the senses of Sight and Hearing.*

When examined in a general point of view, these two senses manifest a great analogy;—both are designed to bring us into correspondence with bodies placed at a certain distance from us;—both enable us to procure clear and distinct ideas, and consequently subserve efficaciously our intellectual faculties;—finally, one of these senses can supply the deficiency of the other, and furnish us with nearly the same notions, as is so conclusively shown by the education of the blind, and of the deaf and dumb. Yet, although these two senses afford so powerful an aid to the developement of our moral faculties, they are far from being unconnected with the internal functions and organic movements;—they even modify them very efficaciously; so that they may be viewed in a double sense; 1. in relation to the instinctive faculties, and first wants; 2. in relation to the purely intellectual faculties.

Section III.—*Of the sense of Sight.*

Structure of the sense of Sight.—This sense resides in a very complicated apparatus, which nature has located in a cavity situated in the cranial and facial bones. Its principal and fundamental part consists of a nervoso-vascular expansion, denominated *retina.* It would be in vain to endeavour to discover in this the structure of what we call nerve; nor is it possible to find in it the gelatinous and firm membrane known under the appellation of *neurilema*—a membrane which exists only in the conductors belonging to the nervous apparatus, but which is found neither in the cerebral sub-

stance nor in the sensitive expansions. The retina consists of a tissue which cannot be dissected, but which is certainly composed of nervous matter and sanguineous capillaries. This structure appears to us to be analogous to that of the cerebral substance, to which the sensitive expansions bear considerable resemblance in regard to their functions,—as we shall prove hereafter. A large nervous cord, passing from the brain to the retina, establishes the communication between these tissues; it consists of a white substance presenting a linear disposition, and containing but few vessels; whereas the retina contains a large number.

The retina is expanded into a convex membrane, the external surface of which corresponds to the choroides,—a vascular tissue, containing no nervous matter, and the colour of which is black. These two membranes are enveloped by the sclerotica, which consists of a capsule of a very solid fibrous texture, having the shape of a vessel of which the bottom corresponds to the cavity of the orbit, where it is perforated by the entrance of the optic nerve, and the opening is in front, between the eyelids. The external surface of the sclerotica is connected with various muscles, with cellular tissue, and a mucous membrane; its internal surface is lined by the choroid coat. The cavity formed by the retina is filled with the vitreous humour, which constitutes a large portion of the mass of the eye: this humour is not loose in the cavity, but confined by a laminated tissue, extremely fine in its texture, and as transparent as itself. This tissue produces the humour in question, in the same way that the arachnoid, pleura, pericardium, peritoneum, and synovial capsules produce the humours by which they are lubricated.

It is not our object here to examine the peculiarities observed in the structure of this laminated tissue; but we must remark, that at the anterior and middle portion of the vitreous we find the crystalline humour, which is much less abundant, but of greater density—having the appearance of a small transparent globe, set in the anterior part of the larger one, which is the vitreous humour, and immediately behind the opening by means of which this apparatus communicates with external bodies, destined to produce the sensation.

This opening, which is denominated the *pupil*, is situated in a membrane placed transversely, and like a kind of diaphragm, in the anterior part of the globe of the eye, which it divides into two sections of unequal dimensions, called *chambers*. The posterior or

smaller chamber corresponds to the cavity we have just described, whilst the anterior, which is much larger, forms a slight projection on the external surface of the ocular sphere.

The diaphragm in which the circular opening or *pupil* exists, is a membrane, which, in consequence of the different colours it exhibits on its external surface, is denominated *iris*. It is a fibrous vasculo-nervous tissue, of the class of those called *erectile*, and adheres by its circumference to the part where the sclerotica terminates, and where is inserted a solid horny tissue, having some resemblance to a watch-glass. This substance forms, as it were, a a small segment of a sphere, projecting on the anterior part of the globe of the eye. It is called the *cornea*, and consists of a transparent issue, seen between the opening of the lids, and behind which the iris and pupillary aperture are discovered. The space included between the cornea, and the iris, with its aperture, constitutes the anterior chamber of the eye; and is filled with an albuminous and transparent fluid, which is free, because it is not contained, like the crystalline or vitreous humour, in a laminated tissue. In consequence of this arrangement, it is capable of being renewed, when, in consequence of an accidental puncture of the cornea, it has been evacuated; whereas the crystalline and vitreous humours, which cannot be evacuated but with their secreting tissues, can never be reproduced.

I shall not dwell on the peculiarities of structure of all these tissues, nor on the direction of the vessels and nervous filaments distributed to them; it will be sufficient for my present purpose, if the reader can form some idea of the general shape and structure of the eye, as well as of the difference existing between the principal tissues of which it is composed.

Such as we have just described are the essential organs of the sense of vision. The accessary organs are, 1. six muscles, which are inserted by one extremity into various parts of the orbitar cavity, and by the other into the sclerotica, and are destined to move the globe of the eye; 2. two prolongations of the skin, forming the eyelids, which are a kind of movable curtains, that nature has placed for the protection of the anterior part of the eye. These prolongations are supported by two cartilages denominated *tarsi*, and moved by muscles corresponding with their posterior or internal surfaces. At the edge of the eyelids, the skin changes into a mucous membrane, appropriately called *conjunctiva;* for after being

reflected behind the skin of the eyelids, and lining the internal surface of the tarsi and a part of that of the palpebral muscles, it passes over the anterior part of the eye, which it covers, so far as the point of insertion of the cornea; in other words, it terminates at the circular opening of the sclerotica: it serves, therefore, as the means of union between the skin and the globe of the eye. In a state of health, the colour of this membrane is white, though small vessels are invariably observed in it.

Behind the conjunctiva, at the external angle of the eye, and in a small osseous cavity, we discover a gland, called *lachrymal gland.* Several small canals, resulting from the union of the much smaller excretory vessels of the gland, open on the conjunctiva, and deposit on it the liquid secreted by that organ. This liquid lubricates the two corresponding surfaces of the conjunctiva, and the external surface of the cornea. It serves to facilitate the gliding of the eyelids over the globe of the eye. The lachrymal gland, moreover, manifests sympathies which render it very remarkable.

Of the Mechanism of Vision.

Such is a general sketch of the apparatus of vision, the local action and numerous sympathies of which, merit the entire attention of physiological physicians. Light is the natural stimulus adapted to the sensibility of the sense of vision. Many other writers having described the mechanical phenomena of vision,* we shall content ourselves with studying this sense in relation to vitality; since it is in this respect that it offers the greatest degree of interest to the physician who endeavours to discover in physiology the explanation of pathological phenomena.

We shall first examine the local phenomena of vision,—in other words, those which take place in the apparatus of the sense; and next trace the results of the sensation in the brain, and in the different apparatus of the economy.

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* I refer more particularly to the Treatise on Physiology by M. Magendie, and to the Memoirs on Vision, inserted in his *Journal de Physiologie Expérimentale.* (D.)

Of the Local Phenomena of Vision.—Of the Sympathies observable in the Ocular Apparatus.

In the function of vision, we discover several sympathies, which, although exercised through the medium of the cerebral centre of perception, are, nevertheless, manifested in the apparatus we have just examined. Light, on reaching the sensitive expansion or retina, occasions in it a stimulation, from which result organic and animal sympathies. The former consist in the contraction of the pupil, and in an increased secretion of tears; the latter, in the movements of the globe of the eye, executed by the proper muscles of that organ, in order to direct it towards luminous bodies, or turn it away if the light be too intense; and in the movements of the palpebral muscles, which tend to the same effect, since they serve to close the eyelids when the light is too vivid, or to separate them when it is feeble. These four sympathies depend always on the same cause: they are determined by the centre of perception; since they are not excited when the brain is engorged, nor during sleep, in which, as every one knows, the eyelids may remain half open, and the rays of light enter the eye. In a majority of instances, instinct alone presides over them; in other words, the centre of perception determines them without the participation of the will, and even in spite of that faculty. But these sympathies offer this difference; that the two first, or vital erections of the iris and lachrymal gland, cannot be modified by the power of volition; whereas the other two, consisting as they do, in muscular movements, are subjected, though conditionally, and in the following manner, to this modification. When light is not too vivid, we are not under the necessity of turning aside the globe of the eye, or closing the eyelids; but, if it be intense, it is no longer in the power of the will to prevent these movements. The same remark may be made, whenever a foreign body, applied to the conjunctiva, occasions pain. Hence, the proper muscles of the eye, and those of the lids, have the same relation with instinct and the intellectual faculties, as those of respiration. When instinct is not absolutely in need of them, they are placed at the disposal of the will; but, under all other circumstances, they are removed from its influence.

In all instances in which we observe muscles under the control partly of the will, and partly of a sense, whether internal or external, we may rest assured, that these muscles are supplied, at the

same time, with cerebral and ganglionic nerves. This is observed to be the case, as regards the ocular apparatus: ganglia, constituting a link in the chain of the great sympathetic, meet behind the eye, and furnish small branches, that twine around the arteries of that organ: on the other hand, we find it supplied with filaments, derived from the cerebral nerves, and more particularly from the fifth pair.

Of the manner in which the Local Phenomena of Vision degenerate into Disease.

An excessive stimulation of the retina may carry the vital erection in it to the point of inflammation, or exhaust its organic action, and throw it into a state of paralysis. In a majority of instances, however, the effects of this super-excitement are developed in the tissues, in which the organic sympathies of this sensitive expansion are exercised. Hence, owing to this cause, the iris, the lachrymal gland, and the conjunctiva, are sometimes inflamed, whilst the retina remains unaffected. Whenever inflammation originates in one of these tissues, it may, if the individual predisposition favour its progress, invade all the others. In our pathology, we shall point out the disorders occasioned by these phlegmasiæ.

The eye, when deprived for a length of time of the influence of the ordinary degree of light, but powerfully exercised by the will, acquires, occasionally, so great a degree of excitability, that the individual is enabled to distinguish objects by the aid of the small number of luminous rays that penetrate into obscure places. In such cases, the pupil is invariably found considerably dilated, and the iris sometimes loses to such a degree, the erectile faculty, that, when the eye is exposed to the light of day, the pupil no longer contracts; and this disposition, combined with the extreme susceptibility of the retina, gives rise to a state of blindness, often difficult to cure. This arises from the circumstance, that, like the cavernous body of the penis, the iris has for its basis a fibrous tissue, disposed in lines, which, from all the points of its insertion into the sclerotica, converge towards the *pupil;* these lines, which may be considered as so many small cavernous bodies, manifest a perpetual disposition to contract, and can only be elongated, advance towards the pupil, and diminish its diameter, by means of the afflux of blood which is attracted into their capillary vessels, through the medium

of the sympathetic influence of the retina. With these facts before us, it is not difficult to understand, that if, during a length of time, a state of erection be not excited in these small bodies, their fibrous tissue finally loses its extensibility, and, like the penis which has remained too long in a state of inaction, they become inadequate to the performance of the function for which they were intended.

Finally, the eye, when too powerfully excited, takes on a state of inflammation or sub-inflammation, is engorged and disorganized in all its tissues ; whilst, on the contrary, when allowed to remain without exercise, it becomes dry, stiffened, withered, and atrophied. Such as we have detailed them are the causes of the diseases of this organ, viewed independently of the influence of the principal viscera ; but the irritations it contracts by the action of a too powerful degree of light, are susceptible of being transmitted to these latter, and more particularly to the brain. The external air may disorder the conjunctiva by the particles it holds in suspension ;—such for example as certain mineral dusts—acids in a state of vapour—smoke —fine sand—the miasmata of certain fogs—ammonia in the gaseous state—the acid exhaled from ant-holes, &c. From these causes acute and chronic inflammations may result.

Of the Sympathetic Phenomena of Vision, developed in other Parts.

It appears to me difficult to explain the sensation resulting from the stimulation exercised on the sensitive expansion called *retina*, by the rays of light. Consequently I shall not attempt to account for it by the purely mechanical laws of optics,—in other words, by supposing an image to be represented on the choroides by the luminous rays that are reflected from each object, as is observed in the *camera obscura*. It is impossible to deny, that the rays penetrate through the pupil ;—that, in passing through the transparent contents of the eye, they converge and diverge in various degrees ; that they fall in pencils on the retina : but all this does not appear to me to explain the almost infinitely numerous shades of vision. All that is satisfactorily demonstrated is, that in consequence of the stimulation exercised by the luminous rays upon this nervous expansion, a perception takes place in the cerebral centre ; and this will suffice to enable us to prosecute the researches which form the object of this treatise.

The sensation is referred to the bodies from which the luminous rays have proceeded; and the acts resulting from it are invariably influenced by the relations that exist between our economy and those same bodies. Whenever the cerebral centre and the eyes are in a state of health, we constantly judge in the same manner of the respective colour, form, dimensions, and distances of these bodies. These judgments are expressed by language in a clear manner, and memory can invariably retrace them with equal clearness. This is the intellectual part: but the different bodies, with the existence of which we are made acquainted through the medium of the sense of sight, are more or less intimately connected with our first wants, by means of eternal and immutable relations: and it is in consequence of these relations that we experience a desire for some and an aversion to others, and that to others again we remain almost indifferent. Hence arises the variety in the acts determined by the will, in consequence of the perceptions transmitted to us by means of the sense of sight; but as all this is equally noticed in relation to the sensations procured to us by the other senses, I shall postpone offering my views until I shall have presented a description of the organs intrusted with these senses.

Section IV.—*Of the Sense of Hearing.*

Of the Structure of the Auditory Sense.—However delicate the sense of vision may be, that of hearing is still more so. We have seen the precautions which the Author of all things has taken, for protecting the sensitive expansion of the eye against all exciting influences except that of the luminous rays; yet these rays penetrate even to the sense itself, and are lost in the substance of the choroid coat.

The same circumstance, however, does not occur in respect to the sense of hearing. Its natural stimulus, the air, does not reach the nervous matter of the acoustic expansion; and this latter, which is much more delicate and soft in its texture than the retina, and bears an exact resemblance to the cerebral pulp, receives only a vibratory motion, communicated to it, not by the air itself, but by tissues which serve to protect it from the immediate contact of that fluid. The portio mollis of the acoustic nerve, which alone presides over the sensation, (for the portio dura is only a nerve analogous to the cerebral pairs destined to the general sense of touch,

and to muscular movements,) is situated in the centre of the hardest of all the bones. This portion of the temporal bone, denominated *petrous*, contains several cavities communicating with each other, and distinguished by the names of *cochlea*, *semicircular canals*, and *vestibule*. The nerve, like the pulpy substance of the brain, which is disposed in lines, is extremely soft, and of a white colour. It floats in a gelatinous fluid, and the membrane which separates it from the bones, and secretes this fluid, so far from being of the consistence of the areolar tissue, which secretes and contains the humours of the eye, is so delicate as to resist all the efforts of anatomists to dissect it. The same remark is applicable to the blood-vessels of this nervous expansion; so that it is impossible to discover in it any thing but a semi-fluid, organized, nervous matter, together with a small portion of free albumen or gelatin.

The vestibule is the point of union of the two laminæ spirales of the cochlea, and of the semicircular canals. A fibrous membrane of an elastic and firm texture closes this vestibule on the side corresponding to the cavity of the tympanum, and prevents all foreign bodies, of whatever nature they may be, from penetrating so far as the acoustic nervous matter.

The middle cavity of the ear, called also the cavity of the tympanum, is, like the former, situated in an excavation of the temporal bone. The air finds access to it through a canal on its internal side, which communicates with the posterior nares, and has received the name of *Eustachian tube*. On the side opposite to this tube, the osseous cavity of the tympanum presents an opening which communicates with the external auditory canal; but which, during life, is closed by an elastic membrane, similar to that of the orifice corresponding with the vestibule. Finally, a fourth opening, situated at the posterior and inferior part of the cavity, leads into cells, in the mastoid portion of the temporal bone. It is not closed; but the cells have no communication externally; so that the cavity of the tympanum communicates with the external air only through the medium of the canal, which terminates in the posterior nares, in other words, the *Eustachian tube*.

In this cavity are found the small bones of the ear: they are four in number, and are designated by the names of *stapes*, *malleus*, *incus*, and *os orbiculare*. They form together a kind of chain, by which the membrane of the *tympanum* is made to communicate with that of the *foramen ovale*, which opens into the laby-

rinth. The *stapes* is applied to the former, and the *incus* to the latter; whilst the *malleus* and the *os orbiculare* are intermediate. Muscles are attached to these small bones, and inserted by their other extremity into different parts of the temporal bone. The whole is covered or enveloped by a membrane, which is a continuation of that of the fauces, and has, from this circumstance, been classed among the mucous tissues.

Such is the internal ear: the external consists of a canal which commences at the membrana tympani, and opens outwards on the lateral part of the head, by a large cartilagino-membranous expansion, denominated the *concha of the ear.* It is a kind of funnel, the form of which varies in different animals. Its figure, in our species, is too well known to require a description in this place. The external ear is covered by the skin; but in proportion as this envelope advances into the external auditory canal, it becomes thinner, and finally almost assumes the character of a mucous membrane.

From what we have already said it may be perceived, that the Eustachian tube and the *meatus auditorius externus* present a great analogy to one another, since they both consist of canals, the smaller extremities of which correspond with the tympanum, whilst the larger terminate externally in expanded openings. They differ, however, in this, that the Eustachian tube penetrates freely so far as the internal ear, whilst on the contrary, the course of the meatus auditorius is interrupted by the membrane of the tympanum. This disposition, however, does not constitute an essential condition for the exercise of the sense; for in many instances the Eustachian tube is obliterated, and, if hearing be prevented by this cause alone, it can sometimes be restored by procuring the access of air to the cavity of the tympanum, by the perforation of the membrana tympani. These two canals therefore, are intrusted with analogous functions, and can, to a certain extent, supply the place of each other.

It results, moreover, from the preceding observations, that the parts essentially necessary to hearing, consist of those cavities which when united together are designated by the name of *labyrinth;* since it is in these, that the nervous expansion of the auditory sense is situated.

Of the Mechanism of Hearing.

The air, the particles of which are agitated by the vibrations of sonorous bodies, is collected by the concha of the ear, and passes into the meatus auditorius: the membrani tympani receives the impression, and its vibration, propagated to the air contained in the cavity, excites the contraction of the muscles of the small bones that are fixed on one side to the membrane of the tympanum, and on the other to that of the foramen ovale. The impulse felt by the latter is communicated to the vestibule, and from this through the whole extent of the labyrinth. Finally, the auditory nerve, which partakes of the vibration, transmits it to the cerebral centre, whence results the perception that constitutes hearing. Such is the explanation of this phenomenon as given by natural philosophers: to this they add, that the air contained in the mastoidal cells contributes to the perfection of the sense, by increasing the vibrations communicated to the foramen ovale.

Hearing may, however, be exercised independently of all these accessaries, since certain animals are not supplied with the cavity of the tympanum—and the sense may likewise be perfect in man, notwithstanding the perforation of the membrana tympani, and the destruction of the small bones of the ear—finally children in whom the mastoidal cells are not yet developed, hear as well as adults. These cells, the extent of which increases with age, and thus augments the power of the vibrations, are perhaps a necessary compensation for the stiffness of the membrane protecting the labyrinth, and for the diminished sensibility of the acoustic nerve.

All animals possessing long ears, direct them towards the place whence the noise proceeds, and thus add very much to the delicacy of the sense of hearing, by collecting and concentrating in the meatus auditorius a greater portion of air in a state of vibration. Man is deprived of these advantages, and can supply their deficiency only by means of artificial ear-trumpets.

Of the Manner in which the Local Phenomena of Hearing degenerate into Disease.

Noise, when too intense, may, by causing a violent irritation of the auditory apparatus, produce in it inflammations and hæmorrhages; or occasion without the intermediate action of these affec-

tions, a disorganization of the pulp of the acoustic nerve, whence results a paralysis producing deafness. When the sensibility of the organs in question remains in a state of exaltation, after extraordinary commotions, the individual retains the perception of a continued and insupportable noise, and forms erroneous judgments of the nature of those bodies that modify the auditory sense.

The perception occasioned in the cerebral centre by the vibration of the acoustic nerve, imparts to us the ideas of noise, sound, speech, singing, and music, which are only modifications of the same phenomenon. These ideas are more or less distinct, according to the nature of the object which has determined the vibrations of the air; because we invariably refer the sensations to the external bodies from which they arise, and never to the modification of our sensitive organs. When sounds convey to us distinct and clear ideas, we are able to communicate them with the same clearness to beings of similar conformation with ourselves, either by means of speech, singing, or music. We even transmit to others, through the medium of the sense of sight, and by the aid of written characters, musical notes, or gestures, a part of the ideas obtained through the auditory sense; but there are many which we cannot convey. These differences depend solely upon the organization of the brain, and not at all upon the sense of hearing. Speech is heard and repeated by all men who are not deprived of the auditory sense, because they are all endowed with a cerebral organization, fit to procure for them distinct ideas on that subject. Music, when viewed as a mere noise, is also heard by every one; but it furnishes ideas sufficiently clear to be re-produced and communicated to those individuals only, whose brain is organized in a manner adapted to this kind of sensation. A similar remark is applicable to a number of noises, which leave behind them nothing but confused ideas; such, for example, as the voices of animals, the accents of which, although we hear them perfectly, convey rarely to our mind a definite meaning. Whenever we hear a foreign language spoken, it at first sounds to us like an idle noise; but as it represents ideas analogous to those of our own language, we insensibly accustom ourselves to associate it with them: whilst on the other hand, it is impossible for us to connect any thing identical with the sounds of various animals. We acquire on this subject only notions, more or less approximate, and often more hypothetical than real: the same may be said of many other noises.

In the preceding remarks the subject is considered in an intellectual point of view. As respects the relation of sounds with the play of our organs, we discover phenomena analogous to the relations of the other senses: I, therefore, defer enlarging upon them, until after I shall have offered the history of all the senses.

Section V.—*Of the Sense of Smell.*

Structure of the Sense of Smell.—It is situated in a portion of the superior mucous membrane, which lines the nasal fossæ and the maxillary and frontal sinuses. This membrane adheres, throughout its whole extent, to bony tissues, and is abundantly supplied with blood-vessels, nervous substance, and mucous follicles. A nerve of considerable size, after having proceeded a short distance in the interior of the cranium, under the cerebral hemisphere, passes through the ethmoid bone in numerous white and pulpy filaments, spreads itself over the membrane, and establishes a correspondence between it and the centre of perception.

The nose, which forms so remarkable a prominence in the middle of the face, serves as its protector, and modifies, by means of the muscles with which it is supplied, the column of air destined to produce the sensation.

Nature, by placing in the interior of the nose small bones, disposed in a spiral form, and called *cornets*, has multiplied the surface in which the olfactory sense resides. There are other bones, such as the superior maxillary and frontal, which, by their winding cavities, contribute to the same end. The ethmoid, finally, presents many furrows, and forms the summit of the olfactory arch. The delicacy of the sense is proportioned to the extent of the ethmoid bone, and more particularly of the cornets situated beneath it, as may be remarked in herbivorous, and in some carnivorous animals, and more particularly in that variety of the dog which is employed in hunting. As the nasal cavities are developed only in the progress of age, the sense of smell is much less delicate in children than in adults.

Of the Mechanism of the Olfactory Sense.

The sense of smell places us in relation with all bodies situated at a distance from us, provided they are capable of emitting parti-

cles termed *odoriferous.* The air becomes impregnated with these particles, and, when drawn towards the lungs by the movement of inspiration, deposits them, as it passes through the nasal fossæ, upon the membrane in which resides the sense of smell.

In order that smell may take place, it is necessary that the lining membrane of the fossæ should be moistened, though not over-charged, with mucus; for when the nostrils are dried or filled up with mucosities, the sensation is almost annulled. It appears, therefore, that the odoriferous particles are blended with the mucus, and applied to the membrane in which the sensation occurs. This operation is very far from being as prompt as that which procures to us the sensation of sight and hearing; for a certain space of time must always elapse before it can take place, and we are often obliged, in order to obtain it, to excite at short intervals oscillation of the air in the nasal cavities, by executing short and successive movements of inspiration and expiration. It sometimes also happens, that smell is not manifested until a few seconds after the air charged with molecules has passed through the nasal cavities—a circumstance that depends upon the same cause.

Of the manner in which the Olfactory Sense may become diseased in executing its Functions.

The irritation excited on the olfactory surface may be so powerful as to give rise to inflammation. Its primary effect is to stimulate gently the membrane, and to promote the secretion of mucus. When long-continued, it produces a state of dryness and heat, which may be changed into a phlegmasia. This sense, moreover, when too powerfully excited, very often loses its delicacy, as is often observed in individuals who make an habitual use of snuff, and who are thereby rendered insensible to smells less powerful than those of the substance to which they are accustomed. When a person is occupied during a few hours in smelling aromatic substances, as happens, for example, to those who are engaged in the study of botany, the olfactory sense becomes blunted, and resumes its accustomed delicacy only by means of rest.

The olfactory sense procures us different kinds of ideas—it apprizes us of the nutritive properties of bodies, and apparently of their chemical composition; whilst, on the contrary, the senses of touch and sight merely afford us a knowledge of their surfaces. It

furnishes few materials to the mind, since we do not derive from it clear and distinct ideas, and our memory cannot retrace them as easily as those which are furnished to us by the three senses we have already examined. Hence we cannot communicate these ideas to other individuals. We recognise an odour we have already smelled; but when the substance from which it emanates is absent, we endeavour in vain to retrace it in our minds, or to excite it in that of others, either by means of words or of figures. But if the olfactory sense exercises so little influence on the mind, it is in return associated by means of very remarkable relations with the viscera, particularly with those of respiration and digestion. In our own species it corresponds in a very limited degree with the genital organs, whilst it modifies them very powerfully in many of the mammiferous animals. From these relations result a great number of phenomena, in which are discovered many causes of disease. We shall examine them in connexion with those of the other senses.

Section VI.—*Of the Sense of Taste.*

Structure of the Organs intrusted with this Sense.—The portion of the mucous membrane intrusted with the sense of taste is situated in the mouth. The tongue is its principal seat; and the nerves by which it is made to communicate with the centre of relation, resemble all those which are destined for general sensibility and muscular movements. The tongue, like the fingers, is supplied, more especially at its extremity, with numerous papillæ, which are made up here, as in every other part, of nervous matter and sanguineous capillaries.

The tongue is a fleshy tissue, the muscles of which are attached, posteriorly, to the styloid processes of the temporal bone; below, to the os hyoides; anteriorly, to the inferior maxillary bone. In other parts it communicates, by means of muscular bands called the pillars of the velum pendulum palati, with the palate bones; and with the pharynx by means of other muscles. It contains longitudinal fasciculi proper to itself, as well as transverse and oblique ones, depending on the preceding muscles. This truly admirable arrangement affords it the power of moving backwards, upwards, downwards, and to each side—of being elongated and flattened when protruded from the mouth—of being shortened and of swelling up so as to form a large mass, which is directed backwards and upwards,

and applied to the roof of the mouth;—in a word, of executing movements in all possible directions. The muscular tissue of the tongue is placed in dependence upon the cerebral centre; and the will may dispose of it, so long as it meets with no very powerful obstacle from the wants of the viscera.

The parietes of the cheeks, which are contiguous with the tongue, and the lips placed exteriorly to the double dental arch, are formed of muscles, covered over by the skin, and blended with a fatty tissue; whilst the internal surface of these parietes is lined by the same mucous membrane which envelopes the tongue. Finally, the velum pendulum palati is in like manner a muscular tissue, separating the mouth from the pharynx, and containing, between two muscular bands situated laterally and denominated *pillars*, a large gland. These bands are attached above to the bones of the palate, and are lost in the lateral parts of the tongue, which they draw up, as we have already stated, towards the superior region of the mouth.

The muscles of the parietes of the mouth are, like the tongue, under the control of the centre of perception; but it is not exactly so with those which form the velum pendulum palati; hence they are supplied with branches from certain ganglia of the great sympathetic, which also furnish some to the pharynx and to the olfactory sense. These ganglia are very small, and communicate with those supplying filaments to the apparatus of vision, and with the branches that penetrate into the internal cavity of the ear.

I do not allude here to the vessels of these various sensitive apparatus, as they do not afford a subject for any peculiar physiological remark. Indeed, it is of little importance to the functions of these organs, through what arterial branches their blood arrives: all that is necessary to enable them to attract into their capillary tissue the quantity requisite for their vital erection is, that some should be contained in the neighbouring vessels:—now every one knows, that the carotid arteries, which are very near the heart, supply a large quantity of blood to every part of the face.

Of the Mechanism and Sympathies of the Sense of Taste.

When the centre of perception has, by means of impressions received from the other internal senses, taken cognizance of the presence of nutritive substances, it commands the movements necessary for taking them, and aliment is applied to the sense in question. The delicacy of taste varies in the different parts of the mouth. The lips judge more particularly of the temperature of the aliment, and being more sensible to heat than the interior of the mouth, they only permit, when consulted, the introduction of substances incapable of injuring that cavity. The extremity of the tongue, supplied as it is, with numerous delicate papillæ, is the principal organ of taste: the palate concurs with it in giving a relish for aliments, and particularly for drinks. Those which are pleasant to the sense, are pressed powerfully by the tongue against the roof of the palate. If the aliment is liquid and agreeable, it is soon swallowed; if solid, the centre of perception moves it by the aid of the muscles of the tongue, lips, and parietes of the mouth, in all parts of this cavity; and subjects it to the action of the different teeth, in order to effect its division, a process depending on the muscles of the lower jaw. Solid aliments produce at first but a confused sensation; as soon as they are triturated and mixed with saliva, the sense of taste becomes more acute: there is now some change in the flavour of the mass, and the movements of mastication tend to approach it to the velum pendulum palati. If the latter, the most sensitive part of which is the uvula, judges it fit to be swallowed, deglutition is performed; if, on the contrary, the alimentary bolus is offensive to the sensibility of the velum palati, it is once more submitted to the operation of mastication, or is even rejected. The velum palati is therefore connected with the gastric sense by more intimate relations than the rest of the mouth; hence we frequently retain in that cavity substances, which, owing to the disagreeable and nauseous sensation they occasion on approaching the isthmus of the fauces, we cannot make up our minds to swallow.

We discover in the sense of taste the two orders of sympathies already noticed in that of sight. Thus, in the act of tasting, we observe: 1st. Sympathies exercised on the mucous follicles and salivary glands, whence the afflux of mucus and saliva: this phenomenon is purely organic. 2d. Sympathies exercised on the

muscles of the tongue, parietes of the mouth, and the elevators of the lower jaw. These latter only take place through the medium of the cerebral centre, and ought consequently to be included among the phenomena of relation.

The centre of perception, attentive to theimpressions produced by aliments on the different regions of the mouth, commands, in virtue of these impressions, the execution of all the movements we have enumerated; but if its attention becomes distracted by some other stimulation, the operation is suspended. When the appetite is keen, this distraction occurs with greater difficulty; in proportion as the former is gratified, the latter takes place more readily. By the force of habit, we acquire the faculty of chewing and swallowing without necessarily directing our attention strongly to the operation; but a moderate degree of it is in all instances required. The same thing occurs in this respect to the masticatory muscles as to those of locomotion; they cannot be moved with regularity but by the express will of the individual. It is very true that instinct, when solicited by the appetite, which has its seat in the stomach, tends continually to determine the will; but this instinct acquires an absolute control over the muscles of mastication, or those of locomotion, only when the will has lost all its influence over these organs. Under these circumstances, instinct may dispose of them, as is observed during sleep, in the delirium of acute phlegmasiæ in which the brain participates, in those cerebral irritations which produce hysterical and epileptic convulsions, and in other diseases of a similar nature. In the greater number of such cases, the muscular movements are irregular; but they may also be regular, since we observe somnambulists, and persons affected with delirium, walk, repeat the manœuvres of their profession to which they were accustomed, imitate the taking of food with its mastication and deglutition, and converse on the subject of the acts which they imagine themselves to be performing. In all these instances the will is in action; but it is so under the control of instinct, and the latter is the expression of the irritation of the viscera, which is transmitted to the centre of perception, and governs it in an exclusive manner. So soon as the visceral irritation is appeased, the will regains its empire, and no longer acts but by reflection.

The sense of taste, as well as that of sight, has other relations with the viscera contained in the different cavities of the body. The brain is invariably the medium through which they are estab-

lished; but we reserve them, together with those of the same order belonging to the other senses, for the detailed history of the functions of relation.

Of the Manner in which the Sense of Taste becomes diseased in the Exercise of its Functions.

Aliments of too acrid, and drinks of too irritating a nature, give rise to inflammation in the cavity of the mouth, excite so powerfully the secretion of the salivary glands as to convert it into a disease, and even occasion inflammation of these organs. In consequence of too long-continued exercise, this sense may become blunted, independently of the satiety of the stomach; but it is never permanently paralyzed, unless subsequently to an affection of the encephalic organ.

The sense of taste, like that of smell, furnishes us with clear and distinct perceptions; we have in our language words to express some of the most prominent among these; such, for example, as *bitter*, *acid*, *saline*, &c. Memory cannot, however, reproduce gustatory ideas in the absence of those bodies which have occasioned them. Neither are we able to make persons with whom we converse understand them either by figures or words. Hence we must confess that this sense, when compared to those of sight and hearing, furnishes few materials to our intellectual faculties. In compensation, however, as we shall have occasion to remark when tracing the history of the internal functions, it exercises considerable influence over the stomach, and addresses itself clearly to instinct. Taste, indeed, is a purely chemical sense; it decomposes bodies, and causes instinct to foresee their influence on the digestive viscera. As we have already seen, this property is principally enjoyed by the basis of the tongue: and to a certain degree by the velum palati; since, at the moment when the aliments are presented, in order to pass the isthmus of the fauces, we experience an eagerness or a reluctance to swallow them, according as they are more or less proper to gratify the wants of nutrition. (E)

CHAPTER VI.

EXAMINATION OF THE ENCEPHALON AND OF ITS SPINAL PROLONGATION.

Description of the Brain.—The brain, towards which all sensations converge, and whence all volitions depart, consists, in a great measure, of albumen. We discover no gelatin nor fibrin, except in its vascular coats and in its meninges ; but the portion of animal matter presiding more particularly over the sensitive functions, exists under the form of albumen. The mass of the latter substance, constituting the brain, assumes two different aspects ; one portion of it being of a gray, whilst the other is of a white colour. The latter presents a linear disposition ; the former, on the contrary, offers no such appearance. The two are intermixed, the gray portion appearing to support and give origin to the white. It would indeed seem that the latter originates in the midst of the other, by radicles or lines, which traverse it for some distance, approach each other, unite in bands, and again separate, intermixing at the same time with the gray substance. Dr. Gall, moreover, says, that whenever a band of white substance is divided into lines or fasciculi, in order to pass through a mass of the gray, it is larger on leaving than on entering it ; because new whitish lines, which originate in the gray mass, invariably unite to the former, and increase the size of the band. It is for this reason, that he considers the gray substance as the nutritive matter of the nerves.

The gray substance is in closer relation with the blood-vessels than the white ; hence it occupies almost the whole of the periphery of the cerebrum and cerebellum, and receives a very large quantity of blood from a vascular net-work, denominated *pia mater*, which invests it over its whole extent. In some parts of the periphery of the brain, and throughout the whole of the spinal marrow, the white substance is situated externally, and adheres to the pia mater ; but numerous and large vessels are discovered to originate in that membrane, and pass between the lines of the white substance, in order to penetrate into the gray matter, which is situated more deeply. The two substances are doubtless both supplied with blood-vessels; but the gray receives a greater number

than the white, and we may even suspect that the colour, which serves to distinguish it, depends on this more than on any other cause.

After having examined the relations existing between these two substances, as also between them and the blood-vessels, we shall next turn our attention to the direction of the white lines or fibres. As many of these lines, when they have reached the periphery, pass through the openings of the cranium, and are continuous with the nerves proceeding to the different parts of the body, it was natural that they should themselves be regarded as the intra-cephalic nervous apparatus, and their arrangement was studied with care. Dr. Gall is unquestionably the only anatomist who has hitherto done this with success ; and I cannot do better than conform to the descriptions he has given.

According to this author, the medulla oblongata is the central point of all the nerves of the human body. On its superior part are found four large white cords, in the centre of which, as well as in that of the whole medulla spinalis, the gray substance is discovered : these are the points of termination of all the nerves that escape through the openings of the spine, or in other words, of the nerves, which, from all parts of the body, proceed together to that common centre.

Of these four cords, the two inferior, denominated the *eminentiæ pyramidales,* pass through the *pons varolii ;* they enlarge as they ascend, and become the *crura* or *peduncles* of the brain. They soon divide into bands, and pass through two masses of gray matter, one of which is very improperly denominated *thalamus nervi optici,* and the other *corpus striatum.* We say improperly, because the optic nerves, in their passage to the anterior *tubercula quadrigemina,* pass along the lateral portions of these bodies without being lost in their substance. These tubercles, themselves, constitute part of the cord in question, and are also continuous with the peduncles and pyramidal eminences, after they have been divided in the masses of gray substance. The peduncles once more approach each other, and are considerably swelled by the addition of a number of other bands, that originate in these masses; they are next enlarged, and spread out in the shape of a fan, and constitute a white membrane, which unites closely with the gray substance of the periphery. This membrane, which from its adhering to the gray substance, is externally of the same colour, presents a

white appearance internally, and conveys to the mind the idea of a kind of balloon, divided into two segments called *hemispheres,* and of a size which would greatly surpass that of the head, had not nature taken care to fold it on itself in the same way as the intestines: these folds constitute the *convolutions of the brain.* It is by means of this contrivance, that the membrane is enabled to be contained within the limits of the cranial cavity. This arrangement is shown to exist by the appearance of the brain in hydrocephalus, and we may, with a little patience, practise an unfolding, by which it will be rendered equally evident in the dead body.

After lining the internal surface of each hemisphere of the cerebral balloon, the white membrane under consideration proceeds towards the internal parts, where these hemispheres are contiguous; and the lines or fibres by which it is constituted, are condensed, and unite under them in order to form what is called the *corpus callosum.* Proceeding afterwards posteriorly and inferiorly, these fibres form successively the *septum lucidum*, and the *fornix,* as well as the *anterior* and *posterior commissures ;* but they are not continuous with the crura cerebri, for the purpose of returning to the corpora pyramidalia.

In order to form an idea of the structure of the cerebellum, we must again direct our attention to the four cords, which are discovered at the superior extremity of the medulla oblongata. It may be remembered, that the two inferior, or *corpora pyramidalia,* went to form the hemisphere of the cerebrum. We shall now see, that the two superior, or *corpora restiformia,* will furnish the white and linear substance of the cerebellum. These two cords soon spread, and unite to the gray substance, placed at the periphery of the cerebellum. We cannot doubt, that the union of these two substances, which constitutes what was formerly denominated the *arbor vitæ*, consists of a membrane folded on itself; but Dr. Gall has not as yet succeeded in unfolding it.

From this, of which the cerebellum is formed, proceed, according to our author, white fibres, the origin and relations of which with the expansion of the corpora restiformia, are not known. These fibres, in converging towards each other, form the pedunculi of the cerebellum, and finally unite at a raphe, on the inferior surface of the *pons varolii.*

If we remove this eminence in successive horizontal layers, we shall discover behind the white covering, resulting from the union

of the returning fibres of the cerebellum, some gray matter intersected by lines proceeding from the expansion of the *corpora pyramidalia:* consequently the mesocephalon is formed of transverse fibres, proceeding from the cerebellum ; of longitudinal fibres, arising from the corpora pyramidalia, and of a gray substance which serves for their support : and yet these two kinds of fibres, proceeding each to its destination, pass near to each other, not only without being confounded together, but even without any kind of apparent union between them. The two hemispheres of the cerebellum are, consequently, constructed on the same plan as those of the cerebrum. The former, as well as the latter, receive white fibres from the medulla oblongata, and furnish others, which unite at their respective centres:—namely, the corpus callosum for the cerebrum, and the pons varolii for the cerebellum. The diverging fibres of these four hemispheres being continuous with the medulla oblongata, from which they originate, are also continuous with all the nerves of the body, since there is none which does not communicate with the medulla oblongata; whilst, on the contrary, the converging fibres are not united to these nerves by their central points of union ; but it is conceived that they communicate with them after a circuitous course, since they are continued with the diverging fibres in the convolutions of the cerebrum and cerebellum.

The medulla oblongata, therefore, and not the pons varolii, constitutes the central point of all the white fibres of the encephalon, which are now regarded as the intra-cerebral nervous apparatus, and also of all the extra-cerebral nerves which communicate with the different parts of the body. If, therefore, there exists a single centre of sensations and volitions, we cannot conceive it to be elsewhere than at this point, which, as the most essential, is also the most hidden, and best protected, of the whole encephalic mass. At any rate, it is very certain, that in rabbits respiration continues, although we remove, by layers, all that portion of the encephalon situated above the medulla oblongata ; and that it ceases, as soon as the part in which the nerves of the eighth pair are inserted is destroyed. [*See the Experiments of Legallois.*] Now, as it ceases also, when an incision is made below this insertion, *(op. cit.)* I thought myself justified in drawing the following conclusions, in a memoir inserted in the *Journal Universel des Sciences Médicales.*

Respiration is founded on the perception of the want of air. This want is conveyed to the centre, by the nerves of the eighth

pair; the centre, by acting on the nerves proceeding from the medulla spinalis, determines the movement of the inspiratory muscles. Granting this, if we destroy the point of insertion of the eighth pair, the want of air is no longer felt, and respiration ceases; by cutting the medulla, below this point, the want of air is felt; but as the central point, to which it has been made known, no longer communicates with the nerves proceeding to the inspiratory muscles, respiration must equally cease. (F)

After this reasoning, I drew the following conclusion. If there is but one centre of perception and volition, it must be situated at the point where the feeling of the want of respiration is experienced, and from which emanates the volition determining the action of the respiratory muscles. This point is situated at the insertion of the nerves of the eighth pair, and is consequently, the only centre of all the perceptions and volitions.

It is without difficulty perceived, that the whole of this reasoning is founded on another fact; namely, that respiration is the effect of a sensation. In the memoir already alluded to, I have taken pains to cite the facts which serve to prove that respiration really depends on this mechanism. I have more particularly called to my aid in this argument the respiration of the amphibious animals, which remains suspended during a much longer period than that of others, and is executed only when the want becomes so imperious as to force the individuals of that class to leave the bottom of the water, in order to seek the external air.

I am not aware of the degree of importance that will be attached to these propositions, by physiologists; but as I am not acquainted with any opposing fact, I am still inclined to adhere to them; and it is on this basis that I propose to establish all I shall have to say respecting the cerebral functions.

The spinal marrow cannot be considered otherwise than as a series of ganglia formed of a gray central substance, and of white fibres placed on its surface. We distinguish in it three considerable enlargements; one cervical, one dorsal, and one lumbar,—in which all the cerebral nerves terminate.

The spinal marrow, when it has reached the last dorsal vertebra, ceases to contain any gray substance; but consists of large nervous cords, supplied with their neurilema, and escaping together with this envelope, through the foramina of the lumbar vertebræ and of the sacrum. Consequently, from the dorsal region, the neurilema

exists in the spinal canal, and does not, as in the superior regions, commence only at the foramina. This assemblage of lumbar and sacral nerves is no longer called *medulla*, but receives the name of *Cauda Equina*.

The neurilema is found in those nerves only that proceed a long distance, in the various organs of the body, before reaching their place of destination. Hence it is hardly apparent in the optic pair, so long as they are contained in the encephalic cavity. These nerves have no other envelope than a very delicate coat derived from the arachnoid, until they pass out of the cranium; they are then contained in a firm sheath, furnished by the pia mater, and embracing the small cylinders of their neurilema. Finally, the acoustic nerves, which never leave the osseous cavities, present appearances precisely analogous to the white lines of the brain, although it is reasonable to suppose that they are covered with a thin layer of the same nature as the arachnoid, and such as we admit to exist in the ventricles, and between the laminæ of the *septum lucidum.*

We are justified in believing, from these observations, that the white and linear substance of the brain is continuous with the nerves, the neurilema of which is very firm; and that it is also contained in those small cylinders that are formed by this envelope.

The neurilema, or envelope of the nerves, is the continuation of the middle membrane of the encephalic apparatus, denominated the *arachnoid.* This, consequently, is the proper time for speaking of those coverings of the brain, which collectively are designated by the name of *meninges.*

The one which is nearest to the cerebral matter, is nothing more than a vascular net-work, derived in great measure from the subdivisions of the carotid and vertebral arteries, which supply blood to the encephalic apparatus. This net-work contains likewise veins, which, however, are of small size, because they deposit their blood in large cavities denominated *sinuses.* A cellular, or rather laminated tissue supports these vessels, and it is this assemblage which constitutes the *pia mater.*

The *pia mater* is covered over by the *arachnoid*, a transparent membrane, of the nature of the serous tissues, and exhaling and absorbing a serum, which appears in the form of vapour only. According to Bichat, the *arachnoid* is a sac without opening,

which, on the one hand, is spread over the membrane adhering immediately to the internal surface of the bony parietes, and, on the other, covers the convolutions, without penetrating between them. It is also found on all the pedunculi of the brain and of the cerebellum—on the medulla spinalis—in the ventricles—around the nerves until they leave the cranium or spinal canal, and upon all the folds of the most external of the meninges, known under the name of *dura mater.*

The latter membrane possesses a much greater degree of consistence than the others, and serves as the internal periosteum of the cranium and spine: its internal layer is detached from the external in order to form various folds, known under the names of *falx cerebri* and *tentorium cerebelli.* These folds serve to support the two principal encephalic divisions, and contain the sinuses already spoken of, which consist of a sort of canals performing the office of veins, that receive the blood from the smaller veins of the pia mater, and deposit it in the jugulars, by which it is conveyed to the heart.

Such is a general sketch of the structure of the cerebral apparatus. The arteries which proceed to the brain and spinal marrow are surrounded by nerves, called *ganglionic,* of which we shall speak elsewhere. The existence of lymphatics in the substance of the brain, has long been denied; but the recent researches of professor Lobstein, of the faculty of Strasburgh, have led some anatomists to admit them.

Dr. Gall recognises two sorts of nerves. The first are the extra-cerebral, which are familiar to all anatomists: he regards them as arising from the different parts of the body, and proceeding to the medulla oblongata, either by penetrating into the cranium through its foramina, or reaching the same part through the occipital hole, after passing into the spinal canal by its foramina. The next set of nerves consists of the intra-cerebral; for according to this author we must view as nervous apparatus, all those white lines which arise from the medulla oblongata, in order to form the hemispheres of the cerebrum and cerebellum. He also considers as nervous apparatus, but situated in the centre of the preceding, all the other white fibres, which unite at the corpus callosum, septum lucidum, fornix, and the commissures. All these internal nervous assemblages, are doubtless nourished by the gray substance in which they originate. Derived from this substance, which is their matrix and support, such of these apparatus as form in conjunction with it the

convolutions of the cerebrum and cerebellum, proceed to, and unite at the superior part of the medulla oblongata, whence we have seen them arise by the four pedunculi already mentioned. In respect to the central apparatus, he does not view them as converging towards the medulla; but rather as independent of it: he acknowledges, however, that they communicate with the former in the membrane forming the convolutions of the brain; which necessarily supposes that the medulla oblongata is also their common centre.

Every one is aware of the use of the extra-cerebral nerves. According to Dr. Gall, the others are particularly destined to the intellect, the propensities and instinct. He even goes so far as to designate, under the generic name of *organs*, the regions of the encephalic cavity, occupied by each of these apparatuses. It is in this way that he recognises the organ of courage—of pride—of theosophy, &c. which signifies nervous apparatus destined to courage, &c. The whole cerebellum appears to him destined to the instinct of propagation. Here commences the uncertain, the undemonstrated, the hypothetical: but since, in the series of animals, the volume of the cerebral hemispheres diminishes with the intellect, although the extra-cerebral nerves acquire at the same time a degree of developement proportioned to the force of the muscles, and the delicacy of the senses, it appears to us evident, that the nervous substance constituting the brain, is actually devoted to the exercise of the intellectual faculties, affections, and propensities. It remains to determine whether these white lines are the principal agents of these phenomena, or whether they are not rather the simple conductors of the sensations and volition, which would then have their seat in the gray substance. This question appears to me obscure; but I do not perceive, in the theory of the German physician, any reason for refusing to admit a central point for all the nervous operations; and from the observations I have already made, I am induced to place it in the superior part of the medulla oblongata. (G.)

CHAPTER VII.

EXAMINATION OR STUDY OF THE SENSATIONS—INSTINCT—AND OPERATIONS OF INTELLECT.

In a state of health, and when there does not exist any feeling created by a morbid condition of the system, every sensation originates from an impression made on a surface of relation. I have said that these surfaces were of two kinds: the external, consisting of the five senses as generally admitted; and the internal, which are of course composed of the mucous membranes, and sometimes of their appendages. We have seen above, that the wants proceed from the latter series, in order to reach the cerebral centre. It is of the highest importance to bear this in mind, in order to form an idea of instinct, and of the intellectual faculties; since these two orders of operations are invariably modified by the condition of the viscera.

Thus, whenever a stimulating impression is made on an external sensitive surface, it is reflected by the cerebral centre to the internal or visceral senses, whence returned to the brain, it gives rise to another sensation, which impels this organ to action.

But the operations of the centre, though all determined by the same cerebral point, are presented to us under two aspects; 1, that of acts which relate to urgent wants, and belong to the domain of instinct: 2, of acts relative to remote wants, by which we arrive at a knowledge of the intellect.

Sect. I.—*Developement of these Propositions.*

The object of all our acts is to increase the duration of pleasure, or to shorten that of pain. When the want is urgent, it gives rise to the operations of instinct; when remote, to those of intellect. In both it is implied that the portion of the brain destined to feel the wants and command the acts, is sufficiently developed, and is not in a pathological state. Let us first examine the operations and the phenomena of instinct.

SECT. II.—*Of the Phenomena of Instinct in general.*

By some physiologists it is maintained that the brain alone presides over the instinctive operations; because they invariably remark a developement of certain regions of the brain, corresponding to certain acts in animals. I am far from wishing to deny that the brain feels the wants, and commands the acts of instinct. I am willing to agree with Dr. Gall, (to whom alone we owe our actual knowledge of the structure of the brain, and more precise ideas of the acts over which it presides,*) that there exist intra-cerebral nervous apparatus appropriated to a certain order of ideas; but I cannot coincide with him in opinion that the brain acts independently of the other viscera. Animals possess invariably the *cerebral organs*, (to conform myself to the language of this author,) which preside over the taking of aliments—the acts relative to generation, such as the seeking after a female or a male, copulation, construction of the nest, incubation, seeking nourishment for and protecting and defending their young, depositing their eggs in a certain place, and fecundating them, and disputing for the enjoyment of a female, &c. &c. Wherefore then do not these animals constantly perform these acts? Because the condition of the viscera, which should solicit them from the brain, is not constantly the same. Whenever the stomach is full, or diseased, the acts requisite for seeking and seizing aliments are suspended. If we remove the testicles, the acts relative to generation, and we know how numerous they are, can no longer be performed. It is alleged that in this case the cerebellum becomes atrophied: even this I am willing to admit; but if it be true that it presides over generation, it has become atrophied only because the stimulus of the sexual organs has ceased to maintain it in a state of action. It is asserted that the loss of sight occasions a gradual obliteration of the ideas which were furnished by that sense. If this fact be certain, it serves to confirm my proposition, by proving that the brain acts only in concert with the other viscera. But let us again direct our attention to generative desires.

* This voluntary tribute of praise from one distinguished physiologist to another, is worthy of attention, as contrasting with the slang and ribaldry, lavished on Dr. Gal by self-constituted critics and small-brained readers of encyclopædias.—TRANS.

If, when a hen is impelled to incubation, we dip its belly several times in cold water, the excitement disappears, and the kind of clucking which accompanies this desire ceases, together with all the other acts which tended towards the same end. How shall we explain this phenomenon, unless we admit that the desire of incubation is suggested to the hen by a sensation which the brain perceives in the abdominal viscera? Similar observations have not been made on insects; but who will assure us that experiments for this purpose will not be devised? Let individuals who cultivate the science of zoology, or the veterinary art, take the trouble of making local bleedings from the vulva of females of quadruped mammiferous animals, at the time of their incalescence; let them apply a great number of leeches, and they will see whether the ardour of these animals for copulation is not in some measure diminished.

It is said that migratory birds are guided only by their cerebral organization; yet it is certain they do not arrive on a fixed day, and that if the opening of spring be retarded by the prevalence of cold winds, swallows appear later than usual, or else retire after having already appeared: but even were such differences not to occur, as the migrations of these birds cannot be the effect of reasoning, it follows that they can depend only on the manner in which the viscera are modified; and I cannot help thinking that the sensations which determine the action of the cerebral centre are perceived by it in the other organs. Cold and heat must operate on them in the same way as on quadrupeds that live under our eyes; and in all these latter we easily perceive that the turgescence of the genital organs, an effect of heat, is the cause of the acts relating to generation; since castration puts a stop to their manifestation. I have already said that the acts which relate to the taking of aliments are subordinate to the wants of the stomach. Now, why should we deny that the changes of temperature which compel migratory birds to depart, act on the skin, and thence on the digestive and genital organs, and determine in these parts sensations which are reflected to the brain?

There are still other instinctive acts of which I have not spoken; they are such as have for their object the avoiding of any imminent danger. These acts are founded on self-preservation, which is itself based on pleasure and pain. Every thing that causes pleasure determines the animal to approach the external agent capable of im-

parting it; whilst, on the contrary, whatever causes pain gives rise to those acts, which have for their object, either to repel the agent or escape from it. If he repel it, he exhibits anger; if he fly from it, fear. Fear and anger are the effects of two different kinds of pain, which are perceived very plainly by the cerebral centre, (if we judge by our own species,) in the organs situated in distant parts of the body; as for example in the chest, in the heart which is agitated by palpitations, in the cutaneous envelope, and more particularly in the abdominal viscera. Now, we have just seen that the other instinctive acts were determined by irritations perceived in these same organs. All these instinctive sensations, and all the acts emanating from them, suppose then a simultaneous action of the brain and viscera.

The physiologists who refer all to the brain, answer these objections by saying, that every visceral sensation, accompanying instinctive acts, is nothing more than an accidental irradiation of the cerebral excitement, which traverses the nervous system without any distinct object; and that, consequently, it cannot be the immediate cause of these operations. I have already anticipated this objection, by proving, that the acts relating to nutrition and generation are subordinate to the state of the internal organs interested in these wants. It only remains, therefore, to apply this answer to the acts relating to self-preservation.—Than this nothing is more easy; since the sensations which keep up anger or fear in the brain, are perceived in the same viscera which preside over the two wants alluded to. It will be objected, that the sensations are not the causes, but the fortuitous accompaniments of anger and fear. To this I will answer by new facts, as common and simple as the preceding. If it be desired that a person should become easily irascible, it is only necessary to produce in him a gastritis, by means of stimuli repugnant to the sensibility of his stomach. Do you wish to restore him to his accustomed mildness, remove that inflammation. If you wish to impart courage to the greatest coward, it is only necessary to stimulate his stomach by means of a substance agreeable to the internal sense residing in that viscus, and particularly by means of fermented liquors. We discover examples of these modifications even among animals. Hydrophobia is kept up in the dog by means of an inflammation of the stomach; and it is to the different degrees of this irritation, that we must attribute his fears, his melancholy, and his fits of rage, during which we find

him braving men and animals, that in a state of health would have put him to flight. Spirituous liquors act on several quadrupeds in the same manner as on man; they exhilarate and inspire them with courage, and pervert entirely their natural disposition. Even if the physiologists, to whom I am opposed, were to assert, that all the influences of the viscera upon the brain are accidental, it would, envertheless, be true, that they exist, and that, consequently, the cerebral centre does not act in an independent manner. But, were they to maintain such a proposition, they would do so without foundation; since nothing can overthrow the proofs I have given, to demonstrate that the brain invariably acts in concert with the internal organs for which the bodies stimulating the external senses are destined.

In advancing these propositions, I do not pretend to deny that there exist, during the exercise of these instinctive faculties, sensations purely accidental; such certainly take place, but they do not disprove the influence exerted by the viscera. For example, during the venereal orgasm, sensations are felt in the eyes, mouth, muscles, joints, &c.: hunger gives rise to others nearly analogous; but they are not of necessary occurrence, and in a great number of cases, in which the want is moderate, cannot be detected; whilst on the contrary, those which reside in the genital organs and stomach invariably take place.

From these considerations, then, there results a fact to which we have already several times called attention; namely, that when the cerebral centre perceives sensations determined in the external surfaces of relation by external agents, in which the viscera are strongly interested, whether for the gratification of the wants of one of them, or for the preservation of life, this centre invariably experiences secondary sensations proceeding to it from the viscera. Hence, in all these cases, it is keenly solicited to execute the acts required by these wants; and these are the acts which we refer to *instinct*.

Still, however, it does not execute them in all cases; and hence arises a difference among the acts which depend on instinct, well worthy of attention. Thus, there are some which the centre is compelled to execute instantaneously; others which it can defer for a longer or shorter space of time; others, finally, from which it can abstain entirely. In proceeding to the investigation of these three orders of acts, we shall finally succeed in discerning the passions, and the intellectual faculties.

SECT. III.—*Enumeration of the Phenomena of Instinct.*

The acts, which cannot at any period of life be deferred, are those which relate to the most urgent wants, or those, the delay of which would instantly endanger the integrity of action of the principal viscera. Of all our wants, that of respiration is undoubtedly the most urgent; hence it is in the play of the respiratory muscles, that we discover the acts, the execution of which it is least in our power to defer. It is always the stimulation of the mucous membrane of the trachea and bronchia that determines inspiration and expiration. Now, if a foreign body be placed on this membrane, we are forced to inspire and expire precipitately;—this constitutes *cough.* If the stimulus be applied to the mucous membrane of the nose, whence it acts sympathetically on that of the lungs, the same phenomenon, somewhat modified, is offered;—this constitutes *sneezing.* I shall explain more fully the mechanism of these two acts, when I come to speak of the respiratory apparatus. Next to the stimulation caused by foreign bodies, we notice that which is produced by the want of fresh air. This is less urgent than the former, and we are able to suspend the acts it necessitates, as is exemplified at every moment in crying, speaking, or singing.

The want of nutrition comes next to that of respiration: like this, it depends upon the stimulation of a membrane of relation,—that of the digestive canal; but the acts which are dependent on it are of several kinds. Those which are solicited in this mucous membrane, as in that of the lungs, by the presence of foreign bodies, are always the most urgent, and cannot be avoided. Thus, it is not in our power to prevent vomiting, and the attitudes it requires; and we can only retard for a time the voluntary movements, which are to concur in the expulsion of fecal matter. But as respects the want of eating, or of drinking, we have the faculty of deferring the acts they necessitate, and even to abstain from them entirely. Nevertheless, in those cases, the viscus does not cease to solicit the brain; and in too many instances the stimulation which the former experiences, causes it to pass to a pathological state, as we shall have occasion to show in another place.

Next to these *instinctive acts,* in point of urgency, are those which relate to the preservation of the life of the individual. Every thing that threatens us with speedy destruction, tends to

give rise to precipitate movements, which are referred to anger, fear, and other passions, of which we shall soon speak. We are able to resist the instinctive impulses to the execution of these acts, but alas! we too often give way to them.

There are still other acts, which may be classed in the same series, or at least there are desires equally subordinate to instinct, and which lead us to act in a particular manner, or to seek repose; such are the inclinations we experience to accelerate our steps, when we feel the external cold,—to remain in a state of inactivity under the influence of excessive heat,—to place ourselves in such a position as will enable us to yield to the want of sleep,—to lie down,—to give way to stretchings, yawnings, &c. We might extend much this interesting series of instinctive suggestions; but what I have said is sufficient for the correct understanding of them.

The acts solicited by the want of reproduction are likewise singularly multiplied, comprehending as they do the movement necessary for the approach and union of the sexes. These may undoubtedly be deferred or even abstained from; but are females capable of preventing the action of the diaphragm, of the inspiratory muscles, and even of the limbs, which take place in aid of the contraction of the uterus? And do we not perceive here, as in the other wants, that the stimulation of an important viscus, disposes of the cerebral centre independently of the will? We have seen in the history of vision, instinctive acts, over which the will exercises no influence; such, for example, as certain movements of the eyelids; and we have found others analogous in the sense of smell, and in deglutition. It is only necessary for me to recall these facts to the attention of the reader.

We must further refer to instinct the acts solicited for the alimentation, preservation, and protection of the infant: they are truly of the same kind; and although they are sometimes eluded by the power of the will, the want which requires them, more particularly among females, solicits it in many cases, with a degree of energy, the effects of which, reason is incapable of annulling.

Though this faculty affords us the power of retarding or preventing, whilst in a state of health, a great number of acts which instinct requires of us, the same thing does not take place in disease. If a viscus be inflamed somewhat intensely, it stimulates the brain with inconceivable energy,—it assumes absolute control over the centre of perception and of volition. It is by virtue of this law that

we are unable to suppress, in an acute gastro-enteritis, the voluntary movements indispensably necessary for demanding and seizing drinks, for refusing solid food in the same disease, for procuring heat during the febrile chill, and cool air in the period immediately succeeding,—for placing ourselves in a manner the most advantageous for inspiration during an attack of dyspnœa, for changing our position in the restlessness depending upon gastric irritation, or arising from some obstacle to the circulation and to respiration, —for speaking, vociferating, singing, rising, walking, running, attacking with violence surrounding persons, or even committing suicide in phrenitic delirium.

We must likewise class under the same head, convulsions occurring in individuals affected with epilepsy, hysteria, apoplexy, tetanus, &c.

All these acts are in like manner subordinate to instinct; they consist merely in a vicious extension of the instinctive phenomena we experience in a state of health, and most of which are tolerably calm. If these depravations were all of which our species offers examples, we should at least not have occasion to blush; but, alas, under certain circumstances in which we have no longer for excuse the morbid state of the brain, this faculty takes on a hideous degree of energy;—I allude to great public calamities. From those who have detailed the terrible event by which the crew of the frigate *La Méduse* were exposed to the horrors of hunger, we learn that the individuals abandoned on the open sea upon a raft, were in a continual state of phrenzy, and gave way to acts of the most disgusting ferocity. What had become of reason under this deplorable circumstance? Was it not overcome, subdued by the irritated stomach? It is true, that on this occasion some men were seen so obstinately to resist this want, as to allow themselves to die. But how much must it not have cost them to do this? Many have confessed it in detailing their torments. It must be allowed, however, that examples of such forbearance, are few in number, and depend upon an extraordinary increase of the influence of the encephalic nerves on the centre of perception; but which, however great, does not prevent the solicitations of instinct. I refrain from sketching the examples of cold indifference towards other men, and of ferocious egotism observed in many unfortunate situations; as for example, in the retreat from Moscow. It is precisely under these circumstances, that we notice the diminution of the influence of

the intellectual faculties, and that we are enabled to appreciate the whole of that of the instinct of nutrition, and of self-preservation. It is at least very honourable for our species, that men in whom by education the intellectual faculties were matured, should have resisted much more than others, under those calamitous and cruel circumstances, the suggestions of instinct;—that they should even have triumphed over them, and offered examples of disinterestedness, generosity and self-denial, of which individuals, over whom the senses predominate, cannot even form an idea.

These instances of heroism are not met with among savage nations, where instinct, uncontrolled by the cultivation of the mind, is displayed in the most energetic manner.

It is now many years, since, extending, in my lectures, the idea suggested by Cabanis, I referred instinct to the influence of the viscera upon the brain. Since that period the opinion has been advocated by a modern writer, who has placed instinct exclusively in the nerves of the great sympathetic,—which, in imitation of Bichat, he regards as alone presiding over the internal functions. It is not thus, however, that I understand it. There are in the viscera cerebral nerves; and it is by means of these that the centre of perception is made acquainted with the wants. It would be easy to show, that the viscera most supplied with cerebral nerves, are also those the wants of which are most energetically felt by the centre of perception. Such are the genital organs, the stomach, and the internal membrane of the respiratory sense.

It is remarkable, that the suggestions of instinct are opposed by the cerebral nervous apparatus, which are charged with the intellectual faculties. Thus the greater the developement of these apparatus, the combination of which constitutes the hemispheres of the brain, the less powerful is the influence of instinct and *vice versà;*—so that it entirely predominates among the animals of the lowest classes, in which the hemispheres are very small, or even entirely wanting. The cerebral centre receives the influence of the external nerves, and of those of the hemispheres, and yields to the most powerful. If, therefore, it be wished to diminish the voice of instinct, it will only be necessary to exercise powerfully, from earliest infancy, the nerves destined to the intellectual faculties,—for then they will predominate; those of the internal senses will act in a less energetic manner on the centre of perception, and the volitions will be more under the control of the mind than of

instinct,—unless, indeed, inflammation should increase the influence of the internal senses, as happens in the delirium of acute and even of chronic diseases.

This appears to me to be the place to speak of the relations with external bodies, which determine the varieties observed in the phenomena of instinct. These relations, doubtless, are inexplicable, depending, as they do, on first causes; but their effects may be observed, and this is a sufficient reason for detailing them.

As soon as an animal is born, the organs of which it is composed are formed in such a manner as to enable them to receive certain impressions, whilst they remain insensible to others; that is to say, as soon as their external surfaces of relation are placed in contact with certain bodies of nature, they experience a stimulation, which is repeated in the brain, as well as in the internal nervous apparatus, and which determines certain acts; whilst the same surfaces of relation are insensible to the action of other bodies, capable of producing impressions on an animal of a different conformation. Each organized being, therefore, possesses peculiar relations, founded upon its own vital affinities, and subsisting only between it and a certain number of external bodies. These last, on being placed before it, are recognised by virtue of the internal stimulation, and the centre of perception immediately commands the acts which are requisite for approach to those bodies, that they may be made subservient to the wants of the animal or of its young; or kept away if they threaten its existence.

In the lower orders of animals, none of these phenomena are the result of reflection; for, deprived as they are of the intra-cerebral nervous apparatus, which, in other beings, confer the faculty of observing and modifying the impression received, they can only obey, undeterred by considerations of danger which they cannot feel. This may be exemplified by a fly plunging into honey, although it must remain in it, and perish. No sooner has a man deposited his excrements in a field, than a number of insects in the neighbourhood, precipitate themselves upon them, for the purpose of depositing their eggs. Have they reflected that this matter was the most proper for the nutriment of their young? Certainly not. They have received an internal impulse, occasioned by the exhalation from the substance in a state of putrefaction, and they obey it instinctively. If similar exhalations arose from another body, unfit for the accomplishment of the same object, they would still obey.

Hence, they are known to seek, on the chenopodium fœtida, and other bodies accidentally impregnated with putrefactive vapours, a place which is incapable of serving for the incubation of their eggs.

Examine the inconceivable multitude of caterpillars which abound in the country ; they seek for, and will be able to recognise, amid thousands of plants, those which are proper for their food ; and each plant has its particular caterpillar and butterfly. Take the nympha of this insect,—cause it to hatch, and keep it away from its plant ; the young caterpillar will die. If, however, you carry it into the middle of a field, it will travel under your eye during several hours, or even days, until it finds a plant like the one with which its parent has fed, and on which itself was hatched,—although this plant has never before been placed in contact with its external surfaces of relation.

The bee will go out and seek for itself suitable flowers ; it will construct hives, and fill them with honey ; whilst its queen will deposit her eggs in each cell, without being disturbed in this occupation by the presence and attentive observation of man ; because they are deprived of those cerebral organs which could render them susceptible of being thus alarmed. The same remark is applicable to the greater number of insects : whereas, the spider, which is provided with these organs, will remain in its hole, if an individual has already touched its web, and will leave the fly, which has become entangled, struggling in it.

The bird, provided with better developed intra-cerebral apparatus, will, notwithstanding its instinctive impulse to seize its food, or to carry some to its young, abstain from it whenever it is noticed by man ; as if it were conscious, that by obeying first impulses, its life, or that of its young would incur some danger. Many other animals, more closely allied to man, will refuse to perform, in his presence, those acts that are necessary for their propagation. In all these instances, the relations have become greatly multiplied. The instinctive impulses which direct an animal to gratify the wants of an organ, are arrested in their effects by more powerful impulses, which compel it to watch over its own preservation, and that of its young.

It is particularly in the class of zoophytes, that instinct presents the utmost simplicity; since in these it exhibits itself only in the acts necessary for nutrition. They do not possess any of those isolated nervous apparatus capable of procuring for them the instinct

of generation, or even, among some of them, the instinct of self-preservation. Every portion of this animal matter seems equally endowed with sensibility,—capable of recognising the aliment by means of the touch,—seizing it and thrusting it into the digestive canal.

Among fishes we discover many sorts of instinctive impulses, but their object is not the same as in insects, because their sensitive apparatus are in relation with different external bodies. The instinct by which they are directed to feed themselves is blind, and susceptible of making neither choice nor exception among those bodies capable of supplying them with nutriment. No sooner have these been recognised by the internal surfaces of relation, than the centre of perception determines the acts necessary for seizing and swallowing them. The carnivorous fishes do not spare individuals of their own species, and devour both their females and their young. Certain instinctive impulses guide them in recognising the kind of water and the nature of the soil proper for their preservation, and likely to supply them with their food,—whereas others direct some among them to procure air on the surface of the water.

The females are able to select a suitable place for depositing their eggs, and the males are led to fecundate them with their sperm: finally, the instinct of self-preservation leads them to shun danger; only, however, when it is immediate, but never to anticipate or retain the recollection of it.

If we now retrograde toward the mollusca, we discover some, as for example the oyster, in which instinct is very limited;—having for its objects, nutrition, self-preservation, and propagation, which are executed by means of relations of very limited extent. Thus their food is always within their reach, and does not necessitate locomotion for seizing it; the care of their preservation is reduced to the closing of their shells; and as these animals are hermaphrodite, and may engender, without the assistance of their like, it follows, that the instinct of generation is still more limited among them, and is in fact merely an organic function. Other mollusca, as the snails, are compelled to go far in search of their food: although hermaphrodite, they require each the co-operation of one like itself, in order to fecundate, and to be in its turn fecundated. From this arises the necessity of more developed nervous apparatus, which in fact they possess; and notwithstanding the slowness of their

movements, they have a sufficient quantity of brain to see danger and endeavour to avoid it.

The ophidia and batrachia are much less imperfect. Nature has provided them with a well-formed head, and with intra-cephalic apparatus, where impressions are sufficiently repeated and contemplated by the centre of perception, to enable them to deliberate, and to compare one impression with another, and decide in favour of the most powerful. Snakes watch their prey, look at it fixedly with open mouth, and wait patiently until it precipitates itself into it. Assuredly these acts are not the results of reflection; but rather the effects of a determination of the centre of volition, resulting from the impression of the viscera, where these animals feel the want of nutrition. But the developement of the intra-cephalic apparatus allows them to perceive the approach of their enemy, to appreciate the danger by which they are threatened, and to postpone the gratification of the want of nutrition, in order to obey that of self-preservation.

If we examine instinct in the prey threatened by the voracity of the snake, we discover something very extraordinary. What is the power which compels the tom-tit perched upon a neighbouring bush to sacrifice itself for the gratification of the wants of an animal creeping upon the ground, at a distance from it? The reptile obstinately pursues it with its looks;—so long as the bird does not perceive the snake, it runs no risk; but if the former rests its eyes for a few moments on those of its pursuer, all is lost, for it will become its prey. The bird is terrified; it cannot abstain from looking fixedly at the snake;—it flies from branch to branch, as if with a view of escaping; and yet it gradually approaches its enemy. This latter continues gazing at it, presenting it at the same time an open mouth; and the victim finally flies of itself into it. These are not mere fables, but facts, which few shepherds have not had occasion to notice. The public papers gave an account, some years ago, of the manner in which a boa constrictor, conveyed to Europe in an English or American ship, was fed. A number of goats had been shipped for its use. The journalist details the particulars of one of the meals of this monstrous snake. They who had the care of it, when they conceived that it was hungry, opened its iron cage and presented a goat. As soon as the animal perceived its prey, it unfolded itself, and looked at it fixedly, with open mouth.

The goat, after hesitating some time, as if undecided between the instinct of self-preservation and that attracting it towards the monster, precipitated itself head foremost into the living gulf which was to serve as its tomb. But the snake, having judged of the impossibility of swallowing it with as much facility as it could an animal of smaller dimensions, seized it by one foot,—enveloped it in its folds,—broke its bones,—smeared it with its saliva; and then seizing it again by the muzzle, succeeded in swallowing it whole.

What a multitude of diversified acts, equally commanded by imperious instinct! But why should one surprise us more than another? They are all alike founded upon the necessity of the preservation of organized beings; but the life of some requires the death of others. I do not see why an animal, destined to become the prey of another, should not be compelled to yield itself up, when the latter is deprived of other means requisite for seizing it. It is generally admitted, that a number of animals are born only to be devoured: such are, among a thousand others, the larvæ of insects, and the spawn of fish, which would otherwise become too numerous. The end of destruction is as much in nature as that of formation; and the acts of instinct, which tend to deliver up a prey to its enemy, are as natural as others, the object of which is to avoid danger or gratify an appetite. Now, it appears evident, that, in order to attain these ends, the Author of all things has invariably made use of the same means—namely, instinctive impulses.

It follows, from a consideration of these facts, that it is utterly impossible to attribute, exclusively, to the great sympathetic nerve, the acts of instinct. No one can refuse to recognise in them a concurrence of visceral stimulations with those proceeding from the intracephalic nervous apparatus;—all of which act conjointly on the centre of perception and volition. Nevertheless, the acts which take place, are not the result of reflection: and when, in animals differently organized, fear, instead of attracting the prey towards its enemy, induces it to escape; or when the same sensation obliges the carnivorous animal to abandon its food, reflection has no greater agency in these acts. They result from the circumstance, that the instinct of self-preservation, being more developed, evidently overpowers all the others;—the differences in instinctive acts being always in direct relation with the conformation of the nervous system. In a word, it is always the relations, established between the bodies in nature and animals, which are operative in these circum-

stances; but which can only be so through the medium of the nervous system. If we wish to have a demonstrative and unanswerable proof of this fact, let us reflect, that all these acts occur only in animals, in which the nervous matter is separate from the rest; and let us remember, also, what has been said above, respecting the manner in which instinctive acts are modified by the subtraction of certain organs, and by the changes which supervene in the sensitive surfaces in which the nervous substance exists in a state of expansion. I have spoken of the impulse by which the hen is led to hatch, and I have said that it was removed, by cooling the abdomen: now, the impulses of this bird, as well as every other, to build a nest, depend upon the same organic cause. It is true, that they all derive, from the conformation of their encephalic nervous apparatus, the faculty of recognising the materials proper for the construction of their nests, as well as that of building them in the most suitable manner for raising and protecting their young; but these faculties are only called into action through the influence of the genital organs; and if this happen to cease, the encephalic nerves, from which they derive this propensity to industry, remain as inactive as if they did not exist.

If we now pass to a higher class of animals, many species of which live familiarly around us, we shall have occasion to notice somewhat different modifications in the instinctive impulses; and the functions of the intra-cephalic nerves will become more evident; so much so, indeed, that we might be inclined to believe, that these animals are endowed with a certain share of intellectual faculties.

Each of these species possesses predominant instinctive faculties, and many are susceptible of being so modified, in this respect, as to become useful to the human species. This last prerogative results exclusively from the predominance of the cerebral hemispheres; for it is impossible to obtain these modifications in animals badly provided for in this respect. The buffalo, among the herbivorous, and the lion, tiger, hyena, &c. among the carnivorous animals, are not susceptible of being educated. So soon as, by their wants, the centre of relation is solicited, they are compelled to obey, whether it be to gratify their hunger or their amorous desires, to fly from danger, to defend their young, or to retire to some obscure place for the purpose of devouring their prey and avoiding the observation of man. It appears, therefore, that their intra-cephalic apparatus, which are at best small, are exclusively subservient

to the orders of instinct, and that the tricks to which they have recourse in order to surprise their prey, are more in the domain of instinct than of intellect.

This, however, is not the case in animals of the domesticated class; for it almost invariably happens, that the instinctive impulses which predominate in them, are likewise those over which the intellect, whatever it may be, with which they are endowed, exerts the greatest degree of influence. The horse, for example, which is so remarkable for its fondness for great muscular efforts, and for the race, is always ready to allow this instinctive impulse to be modified by the voice and signs of his master. The noble animal seems to understand, that it is in this way he may make himself useful; and accordingly submits to all that is required of him. It is not to avoid chastisement that he accelerates his speed, or increases his powerful muscular efforts; but to please those to whom he has devoted his services. He is susceptible of emulation in his favourite exercises, and of a kind of point of honour, to which he often sacrifices even life itself. But the intellect of the horse is not limited to this. He enjoys, even to a considerable degree, the faculty of memory; and when he succeeds in comprehending what is desired of him, he executes it by himself, and in such a manner as to surprise persons unaccustomed to observe him. It is only necessary, in order to be convinced of this, to witness occasionally the equestrian exercises of the celebrated Franconi. The horse, at the same time, is docile and timid; but he becomes sometimes courageous, and even intrepid, when sustained by the presence of man, and particularly when marching with his like. It is from this circumstance, that our own species has been able to reap so much benefit from his services; but, although he can distinguish his master, he becomes very much attached to those who feed him, and very soon accustomed to the new hand that guides him.

At any rate, the intellectual faculties and the capability of education of these animals vary considerably, according to the greater or less developement of their cerebral hemispheres, as may be discovered, agreeably to the remark of Dr. Gall, by the external conformation of their sculls; whilst their instinct, depending, as it does, upon the state of the viscera, is far from presenting such notable differences.

The dog, the sea-horse, and the elephant, are perhaps, of all

animals, the most intelligent. They manifest gratitude towards the one who takes care of them; and obey with pleasure his least signal. They preserve a recollection of the service or harm done them; but the dog surpasses all other animals by his almost heroic devotedness to our species. His attachment is not limited to the mere gratitude for the food which is given him. He is susceptible of feeling a real friendship, by which he is made to experience pleasure in serving his master, even when harshly treated; whilst, at the same time, he manifests a less degree of attachment to the servant from whom he receives his daily food. He observes all the members of a family, distinguishes the degree of importance and consideration of each, and never fails to have more deference for the master than for all the rest. The caresses he receives from the former are more grateful to him than those of any other. He experiences pleasure in accompanying him,—in rendering him service,—in devoting himself to him,—in sacrificing even his life to please him. If he receive a merited chastisement from his master, he forgets it instantly, and caresses the hand that beats him,—he reads in his looks, and anticipates his desires,—he defends him against his enemies, and recognises them by the manner in which they are received,—he guesses their intention of injuring the object of his attachment, and even foresees the harm they are about doing him. He very often possesses the most certain characteristic of true attachment; that of expressing good will to the friends of his master. His delicate attention extends even to inanimate objects,—he guards carefully the things his master has entrusted to his care, and loses his life rather than suffer them to be forced away. He pays a deference to old age, protects infancy, and disdains to take revenge on a powerless enemy. In a word, this animal possesses qualities, which, in the human species, would be held up as virtues.

These qualities, however, are not the same in all species of dogs; but it is observed that their number is proportioned to the volume of the cerebral hemispheres; and that the developement of one sense modifies them by causing certain parts of instinct to predominate. Thus the greyhound, whose head is very small, manifests very little attachment for the individual who takes care of him; whilst the excellence of his sight impels him, in opposition of the orders of his master, to pursue his prey. It is for this reason, that the pointer is so overruled by the predominance of the sense of smell, that

it is necessary to have recourse to the severest chastisements to compel him to employ this sense to the profit of the huntsman. The instinct of the shepherd's dog, by which he guards and guides the flock without any reference to his own appetite, is really surprising; but it is more particularly in the water spaniel that those qualities, which might be called moral, are exhibited in the most admirable degree. This dog unites memory to intelligence and the sense of smell; and it is in individuals of this species, that instinct seems most susceptible of being modified by education; witness the famous Munito, which was seen by all the inhabitants of Paris to perform card tricks, play a game of domino, assort colours, &c.

It is owing to their strength and disposition to fight, that the mastiff and the house dog are enabled to render us such important services; it is also in this respect that education may succeed in modifying instinct. Danger does not alarm the terrible animal;—caresses—the temptation of aliments often greatly required, do not succeed in corrupting his honesty; he knows, of the whole human species, that being only, to whom he has consecrated his existence. No sooner has his master spoken or made a sign, than the enemy he has designated is prostrated, or the animal perishes gloriously. But he does more; he watches, alone and in the dark, over the life and property of his master; and, without being encouraged by the voice or presence of the latter, he protects him against every kind of aggression, and sacrifices his life at a distance from him with the view of insuring his repose.

The instinct of generation is very imperious in the dog; and it is perhaps in this respect, that he becomes less docile to the commands of his master;—because, in this animal, the force of the passions is greater than that of the intellectual faculties. These passions, which result always from visceral impressions, torment him during his sleep, and render him susceptible of dreams. He recollects then what he has done while he was awake;—he experiences tender feelings or anger, as is shown by the various inflections of his voice, and the movements of his tail and ears. Nevertheless I have not remarked that the genital organs were excited during sleep; whereas they are easily called into action by the presence of the female.

Whatever may be the portion of intellectual faculties, with which the most perfect animals seem endowed, when under the influence of external exciting agents, nothing announces that they reflect on

themselves; it is always by one instinctive impulse that another is modified. They are never seen to form and adopt a plan of conduct different from the one they have hitherto pursued, and which point out positive deductions drawn from what has before happened to them. It is true, that some wild animals are sometimes seen to abandon a haunt, in which they are too often disquieted, for the purpose of seeking out another, where their enemy will cease to pursue them; but this is always an effect of instinct. The idea of disquietude becomes associated in their limited intellect with that of the place where they have experienced these troubles; they consequently abandon it; but as soon as they again become tranquil, they do not think of improving their situation; they enjoy it without anticipating a happier futurity. These results I cannot refer to any other cause than the voice of instinct. Have these animals ever been known to sacrifice the present for the future,—to renounce one kind of happiness in search of another, and, like man, often pursue a chimera during the whole course of their lives? Have they been known to betray symptoms of avarice,—of that passion which is nourished, during the whole course of life, only by the prospect of a futurity happier than the present time? They enjoy the latter, not from calculation, but because they have not the least idea of the possibility of a better condition. When once their desire of food, repose, sleep, protection from agents threatening their existence, is gratified, they are not kept awake by the anticipation of another state, by reflection on themselves, or by the necessity of contemplating nature: they sleep, and are only aroused by the wants of the viscera. They have no spoken nor written language.

Some may perhaps argue, in favour of the existence of reflecting faculties in animals, the propensity of many of them to live in a state of society,—their attachment for each other, and for man,—the possibility of taming their disposition, and forcing them to live with their prey, without danger to the latter,—the tricks they resort to to seize it; as for example those of wolves, foxes, or dogs, which respectively call each other, and unite together in order to triumph over an animal more powerful than themselves,—which allot to each other the part to be performed in the attack or defence,—some pursuing the prey, whilst others place themselves in the path it must follow, with a view of throwing themselves upon it at the favourable moment. They may likewise offer in proof of their opinion, the simulated flight of the wolf with a view

of decoying a young horse from its companions, and attacking it behind as soon as it turns to rejoin them;—the skill which some display in deceiving the enemy that pursues them; as for example the stag, which throws the dogs at fault by making a leap from the track, and hiding itself in a thicket, whilst the astonished hounds seek its footsteps in the neighbouring parts; or the singular trick of the old stag, which, when exhausted with fatigue, will start out a young one, take its place, and allow the dogs to pursue the latter. All these examples, and a thousand others of the same kind, are familiarly known to huntsmen, and those who spend their life in observing animals.

All this, doubtless, points out a certain degree of intellect; and it is not without cause, that the brains of birds and mammiferous animals are provided with hemispheres. But this intellect is in no respect comparable to that of man; and I defy those who imagine they acquire importance by contradicting others, to cite a single fact which points out in animals the character we have assigned to man in his love of self-observation,—of contemplating nature, and of accounting to himself for what occurs around him. (H.)

Sect. IV.—*Of the Intellectual Faculties.*

This subject is of so serious and delicate a nature, that I approach it with a considerable degree of hesitation. Nothing shall prevent me, however, from repeating what has been said by the best physiologists,—that man derives his intellectual faculties from the relative volume of his cerebral hemispheres. This fact is so evident, that it is only sufficient to mention it. Let us, therefore, go farther, and expose our views relative to the characteristics of human intellect.

The power of reflection, as we have already said, constitutes the characteristic of this intellect; now, as a celebrated philosopher has said, to reflect is to feel. Man not only feels the stimulation produced in him by external agents, and by the movements of his own organs, which constitutes *sensation*, or in other words *perception*, but moreover feels that he has felt these stimulations: he observes himself feeling, and says, *I feel that I feel.* Consequently he has the perception of his actual perception. This constitutes *mental reflection.* He may repeat this as frequently as he thinks fit;—he may observe all his sensations, and the different ways in which he

felt, while he observed himself occupied with his feelings. From this study he derives an idea of his own existence, independent of every other object in nature;—he distinguishes himself in the midst of creation, and if he pay regard only to his own existence, compared with all that is not himself, he pronounces the word *I*, and says *I am;* and if he views himself in action he says, *I act*, *I do*, *&c.*

The perception of himself modified by other bodies, procures for man what are denominated *Ideas*. This is, therefore, another result of reflection,—or, in other words, of the faculty he possesses of feeling himself feel: but man feels, moreover, that he has already felt;—this constitutes *Memory*. He cannot exercise a single judgment without calling this faculty into action, since it is always necessary, in order to judge, that he should experience two successive perceptions; that is to say, that he should feel them alternately, which he could not do, unless he possessed the faculty of renewing that which he felt an instant before; or in other words, unless he possessed memory. Hence, the loss of this faculty necessarily occasions that of judgment, and reduces man to a state of imbecility.

In comparing two perceptions with each other, man only feels them successively; and this operation gives him a third perception, which is *Judgment*. Consequently, to judge, is also to feel; and as, in this case, it is always himself who feels himself experiencing sensations—in other words, who reflects his *self* on himself, or, if you will, on this same *self*, we may say that judgment is nothing more than reflection. Hence, *sensation*, *reflection*, and *judgment*, are absolutely synonymous, and present to the physiologist nothing more than the same phenomenon.

The will, or that faculty by virtue of which man manifests his liberty, by choosing, among different perceptions, the one he is to obey,—that faculty which gives him the power of resisting, to a certain extent, the suggestions of instinct, is founded on reflection. Consequently, when we consider it in a physiological point of view, (to which it is our intention to restrict our remarks,) we can only discover in it the faculty of feeling ourselves, and of perceiving that we have this feeling.

Such is the manner in which I view the intellectual faculties; and, as my senses do not enable me to perceive similar operations in animals, nor to discover them by means of induction, I am justified in affirming, that, at least in my opinion, animals are not

endowed with the power of reflection; that, consequently, their intellectual faculties cannot be placed on a parallel with ours; and that their ideas also are of a different order.

After an attentive examination of the subject, it will be found, that reflection necessarily implies the faculty of contemplating nature; since man cannot reflect otherwise than in feeling himself sensible of what passes around him. Animals not being endowed with this faculty, are of course deprived of the power of reflection, which attribute, consequently, becomes the exclusive characteristic of man.

Some persons might, perhaps, attempt to invalidate the correctness of the opinion already advanced,—that judgment invariably implies the existence of memory, by objecting, that individuals, in whom the latter faculty predominates, are not greatly distinguished by the rectitude of their judgment. To this I answer, that if the sentient faculty be powerfully employed in recalling to the mind old perceptions, it is less so in being impressed with the relations they may bear to ourselves. There are very multiplied shades in the reflecting faculty. All men are endowed with it; but those who possess it in a less degree, experience a greater pleasure in feeling the impressions of external agents; and, as we are in absolute need of emotions, this class of individuals procure them by renewing in their minds old impressions, on the occasion of new ones; or rather, they are governed, owing to the peculiarity of their cerebral organization, which facilitates the recurrence of old impressions, by the pleasure they experience from these sensations. Some, on the contrary, always in consequence of the peculiarity of their organization, occupy themselves with studying the effects which these sensations produce upon them; that is, they derive more pleasure from the exercise of the faculty of reflection, or from the secondary sensations, than, as in the case of the others, from the primary ones. These latter are not, however, limited to this pleasure; they continue to reflect on the sensations they experience, though less profoundly than the former; that is to say, their consciousness is more seldom reflected on itself. But, however this may be, the mechanism of the phenomena is the same in both instances;—implying always the return of past sensations and the comparison of these with present ones. The only difference, therefore, consists in the former class of these individuals being less retentive of sensations than the latter. Some are so fortunately organized, as to

possess, in a high degree, the faculty of recalling past sensations, as well as that of retaining others of every kind, with a view of submitting them to reflection. But, as the pleasure of reflection, or rather of the sensations which these individuals procure for themselves, is greater than that resulting from the sensations produced by external agents,—reflection giving them a degree of superiority over the rest of men, and flattering their vanity, they willingly acquire the habit of this kind of intellectual operation, and always come at last to neglect their memory.

After all, the aptitude for reflection, and the pertinacious exercise of this faculty, are not sufficient to constitute sound judgment, which though it implies their existence, is not a necessary consequence of them. Thus we often see profound thinkers, whose judgment is eminently false. The soundness of this faculty supposes a just medium in the degree of the impressions received; for, if too weak, they do not give rise to any intellectual result; and if too powerful, they lead us to form judgments not conformable to the natural relations of things. It is thus that some maniacs, and the greater number of individuals labouring under chronic inflammation of the digestive organs, judge very erroneously of a number of objects, although they are impelled by an irresistible propensity to retain the impressions, and contemplate them to excess. The same occurs in persons whose brains are unduly developed; for, by reflecting too profoundly on their own sensations, they acquire confused ideas of them, and finally become undecided—they cannot form a determinate opinion on any subject; they become inconsistent in their conduct, so that it even appears the result of a want of due reflection.

The intellectual faculties are doubtless one of the results of the functions of the brain; and yet this result is not continuous. It offers considerable intervals, during which the cerebral action is not annihilated, but only withdrawn from the empire of *self*. This I propose to prove by facts, showing at the same time, that physiologists have greatly erred in their definition of sensibility, when they simply say, that it is the effect of the action of the nerves and brain,—in the same way that locomotion is the effect of the action of the muscles,—digestion of the functions of the stomach,—respiration of the action of the lungs, &c.

To the brain is assigned the duty of sending back by means of the nerves, to the various parts of the body, the stimulations trans-

mitted to it by the same channel: this operation is purely organic. It is in this way, that the brain establishes sympathies between the different organs, and makes them subservient to the preservation of life: this constitutes its constant function. It begins to perform this function during fetal existence; and in the period of utero-gestation it has no other. As soon as the child is born, it speedily manifests its susceptibility of experiencing pleasure and pain; this is an extension of the function performed by the brain before birth. After its wants are gratified, it falls asleep; or, in other words, falls again into the same state in which it was whilst contained in the uterus. There is no longer for him either pleasure or pain; hence there is no sensibility: we know that he is susceptible of it, but nothing indicates its actual existence. His brain continues to grow; and when it has attained a certain degree of developement, the observer may notice the first rudiment of consciousness: this constitutes a further extension of the cerebral function. The child once more falls asleep, and this second effort, like the first, is annulled; but as we recollect its having enjoyed consciousness, we say that it possesses it. Finally, the child attains the age of manhood; at this period sensibility and reflection are manifested in their full vigour; but, as soon as they have been exercised for a certain period, they are made to disappear by an imperious law. Man falls once more asleep, and, although, during this time, he ceases to exercise these faculties, the brain continues to receive stimulations through the nerves, and to transmit others by the same means to the different parts of the body. This is shown by the fact, that if some internal or external sense be placed in contact with a stimulating agent, not only the limbs are moved, but the heart and other viscera receive an impulse, by means of which their movements are precipitated. They become injected with blood,—their secretions take place more actively;—in a word, a number of sympathies depending on the brain are called into play.

Let us be understood: if it be maintained that sensibility and mental reflection constitute functions of the brain, it will be necessary to admit, that these are not the only functions of that organ, and also to confess that they are intermittent.* Consequently they

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* To admit the intermittent functions of the brain and nervous system generally, is no new demand on the faith of physiologists. One of the leading distinctions estab-

cannot properly be defined to be *the effect of the action of the nerves and brain*, or, more vaguely still, *the action of the nerves and brain.* They must necessarily be viewed as one of the results, or as one of the effects of this action; and we must admit, that organic reflection, or the transmission of stimulations from parts receiving them, to other parts, constitutes the principal function of the brain and nerves. In order to elucidate the question still more, it is necessary to add, that man has at times the consciousness of this transmission, and that he modifies it, as is manifested by the phenomena which we denominate sensibility, and the intellectual operations resulting from it: whilst at other times he is not conscious of it. During the early periods of his life, when in the uterus, he does not possess this consciousness; he acquires it afterwards, but loses by means of sleep, and reacquires it, periodically; finally, he is deprived of it during attacks of apoplexy, and epilepsy,—and syncope, asphyxia, &c.; but during these several states the grand function of the brain and nerves—the transmission of stimulations, continues uninterruptedly: it is only diminished and irregular, but cannot cease except by death.

This manner of viewing these functions is very important in pathology, as it destroys those arbitrary divisions by which the different shades of the same function are usually separated. It shows, that a point of irritation, as for example an inflammation, acts always in the same way when it calls the sympathies into play, whether the individual be conscious or not of its existence. For example, in the commencement of an attack of acute gastro-enteritis, sensibility and mental reflection are as yet unimpaired; the patient is conscious of his condition, and refers, himself, the uneasiness he

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lished by Bichat, between the animal and organic lives, or the functions of relation and those of assimilation, was the alternate states of action and repose of the former, over which the brain presides, and the continued action of the latter, the centre of which is the heart. The office which the author attributes to the brain and nerves, viz. of organic reflection, or the reception and transmission of stimulation has never been disputed to them: but he errs in calling this their principal function. It has been proved by Bichat, Wilson Philip, Flourens, and others, that for the exercise of sensibility, it is sufficient if that part of the brain where the nerves meet, that is, its basis, be preserved. The great body or mass of the organ may be removed, without impairing sensibility, showing, 1, that this vital property does not reside in the whole brain, or the major part of it; 2. that the object of the cerebral organization is for other higher and more varied functions, with which sensibility may be associated as evidence of vitality, but not proof of unavoidable official connexion.—Trans.

experiences, and even his fever, to the pain of his stomach ; because he very plainly observes, that these phenomena are aggravated or diminished according as this viscus is stimulated or calmed by the substances introduced into it. When, however, the disease is much aggravated,—when the patient no longer speaks or hears, and is in fact in extremity, sensibility has disappeared, together with every sign of the existence of consciousness. Yet still the unfortunate being continues to be agitated by the same movements as before ;—they are even more intense, amounting as they do sometimes to convulsions. What would we think of the physician, who, after admitting with the patient, at the commencement of the attack, that the fever and muscular agitation depended on the irritation of the stomach, should affirm that in the latter stage these symptoms are no longer the effect of this cause; because the patient no longer complains of pain, nor regulates any of his movements? For my part I am inclined to believe, that this physician would be in the wrong; but it appears to me, that all difficulty may be obviated by saying, "the stimulation of the inflamed stomach, transmitted to the brain, and to the whole nervous apparatus, occasions from the commencement of the attack in this patient, the acceleration of the pulse, and the convulsions he experiences; but the changes which have supervened, in the condition of the encephalon, having suspended all the phenomena of consciousness, the patient is no longer sensible, as at the commencement of his disease, of this transmission."*

It is for this reason, that I regard contractility as the only vital property of the tissues, and sensibility as one of the results of the play of this property ;—a result which is not continuous nor necessary to the existence of animals, as is proved in the fetus, in zoo-

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* Here the author confounds sensibility with consciousness—a mistake which pervades his whole reasoning on the subject. We would ask how the convulsions alluded to in the text are brought on, if not by the transmission of the gastric stimulations to the brain and their subsequent reflection from the latter to the voluntary muscles. This may take place in sleep or in advanced disease—it is a process accomplished by two nervous chains of reception, and return, which have a common centre ; it does not call on, or imply consciousness ; and yet it is an effect of cerebro-nervous action, to which no other name can be so appropriately affixed as sensibility. It may take place with an exceedingly small centre, too small for the display of intellect, or even of any variety of instinctive acts, and in the higher order of animals is not incompatible, as remarked in a former note, with the ablation of the greater portion of the encephalic mass.—Trans.

phytes, &c.;—which is subordinate to an inexplicable condition of the brain;—a result, finally, which appears to me so astonishing, so difficult to conceive, that, with all philosophers, I regard it as immaterial. And indeed if thought be considered as such, sensibility, on which it is founded, cannot be viewed otherwise. We notice, it is true, that thought is manifested in consequence of the movement of matter; but I cannot seize the *quo modo*. It is impossible to say what is the necessary result of the movement of the matter which constitutes the brain; since we observe that this organ is agitated,—moves the organized machine,—connects together all the movements, and maintains life, even during a long time, without the manifestation of thought, and consequently of sensibility. What then is the condition of the brain which produces these phenomena? I know not, and consequently will repeat, that sensibility consists in an immaterial, and, at least to me, incomprehensible result of the exercise of our functions.

But I have said that sensibility is a forced state; and my reason for saying so is, that it cannot continue long. The proof of its being painful to nature is that she suspends it, and that if by the power of volition, we prolong it beyond the limits she has imposed, we become diseased; whereas the exercise of contractility is never interrupted. It will perhaps be objected, that every immoderate exercise of this same contractility is also a disease. Admitting this to be the case, and I have never thought of denying it, it is not on this account the less true, that sensibility is a forced state which is painful to nature: these two facts do not, in the least, contradict each other. I will even say, that they agree perfectly; since the state of sensibility cannot occur without an exaltation of contractility in the nervous apparatus, and, consequently, also in the vascular system of the principal viscera.

After having discussed the subject of the intellectual faculties, considered in their relations with those organs, by the action of which they are rendered evident, I must next examine them in reference to the external objects, which give occasion to their manifestation; in other words, I intend to examine these faculties when called into action by the impressions produced on our surfaces of relation, by the different bodies in nature. By this study we shall be led to that of the affective movements, and of the passions.

Philosophers have often repeated the axiom, *Nihil est in intel-*

lectu quod non priùs fuerit in sensu, and to this opinion I am ready to subscribe; but I place among the senses the mucous membranes of the respiratory, digestive, urinary, and genital organs; and my reason for doing so is, that they are sensitive surfaces. It is on the result of impressions made on these internal senses,—impressions which are more or less powerfully repeated in the neighbouring nerves and in the other tissues, and which are analogous to those produced on the external senses, that the centre of relation operates. We have demonstrated, that the brain, when it orders movements in consequence of impressions transmitted to it, does not act alone. We shall now examine in detail, though not with a fastidious minuteness, the acts depending on that organ, in which it is most powerfully under the control of the other viscera, as well as those in which it is least subservient to their influence. In doing this we shall be able to see, that this difference is purely subordinate to the nature of the bodies producing the impressions and placed in contact with the different surfaces of relation.

When the impression is produced on the external senses, by a substance which very nearly interests the viscera,—such, for example, as an aliment,—air, more or less proper for respiration,—a destructive agent, as a menacing enemy, an enraged and powerful animal, a precipice,—a voluptuous object, as the body of a female placed in contact with that of a man, and *vice versa;* when these impressions, I repeat, are produced on the external senses, as those of sight, hearing, smell, or touch, the viscera are instantly agitated. A secondary impression, proceeding from the latter, reaches the centre of relation; and it is in consequence of its advice, that, if not influenced by another impression which we shall soon examine, it is determined to action.

During the first periods of infancy, and before memory becomes stored with recollections, the centre of perception obeys the suggestions of the viscera. In this state man approaches still to the nature of animals; but at length his intellectual organ becomes perfect,—he acquires abstract ideas, and he soon attains that point at which he no longer judges of impressions solely in reference to his actual wants, but rather agreeably to the prospect of a future pain or pleasure,—which induces him often not to obey the calls of a viscus soliciting him to action. It is thus that a religious man resists the desire of nourishment, from the fear of a punishment with

which he is threatened by the dogmas of his creed, or from the pleasure he experiences in thinking that the privation he thus imposes upon himself will be agreeable to God, and will obtain for him the enjoyments of a purely intellectual life. The idea is even to him a source of pleasure at the moment, and this is sufficient to make him silence the suggestions of the viscera. Another individual will be guided by other pleasures apparently very different from these, but which yet are of a similar nature. A mother is solicited by the want of nourishment; but the love she bears her child causes her to anticipate more pleasure in gratifying the wants of this beloved being than in providing for her own. The aliment she might have used herself, is therefore given to the child;—and this sacrifice procures for her a degree of enjoyment, well calculated to compensate for the privation she imposes upon herself.

But this is not all:—man is endowed with the faculty of creating for himself pleasures from motives far less elevated, and which sometimes are not even plausible in their nature. A Hindu fanatic is tormented by the want of aliment, but resists it in consequence of the pleasure he experiences in appearing an extraordinary man, and in attracting the respect and admiration of the multitude. With the same object in view, he imposes on himself the law of mutilating his body, and of preserving, during several years, a painful attitude. In fact, these sacrifices are regarded as something supernatural, because every one feels how painful they must be. From this consideration result praises and a degree of respect, which become, for the one who has had the courage to subject himself to these painful trials, a source of pleasure, of which, as being intellectual, all men are not susceptible.

Courage, which consists in despising death, is founded on similar enjoyments, when not inspired, as it generally is, by anger, or the instinct of self-preservation, &c. One man exposes himself to danger, under the influence of a sentiment of anger; or, in other words, in consequence of the pain excited within him by the threats of an enemy;—another, in order to escape from danger which appears unavoidable;—a third, in consequence of the pleasure he anticipates from vengeance;—a fourth, in order to procure for himself the pleasure of being esteemed and admired;—a fifth, from the fear of experiencing the moral pain accompanying contempt;—a sixth, in the hope of obtaining, by means of martyrdom, an enjoyment

purely intellectual, which will ensure him the admiration of men, or the good will of the Deity, for whom he had the courage to sacrifice himself.

The domain of the intellectual faculties is immense. Very often we see men sacrifice the pleasure of gratifying the actual wants of the viscera, to motives much less powerful than those of which I have just spoken; but which are always founded on the prospect of a future pleasure or pain. For what reason do so many literati, artists, warriors, diplomatists, deprive themselves of their sleep, and renounce all sensual pleasures,—the sources of which are constantly before them, if it be not to enjoy one day the esteem and admiration of their fellow citizens, or more simply, in order to procure themselves, at a period more or less remote, the means of gratifying the very wants they now affect to despise? Some will reply that it is to provide for their children, elevate their families, or please their sovereign, &c.: admitting this, it does not the less follow, that in all these cases they have succeeded in creating for themselves an intellectual enjoyment, which appears to them a sufficient compensation for the privations they have imposed upon themselves.*

It may, perhaps, be further objected, that the desire or hope of discovering a new truth, is sufficient to induce them to submit to the most cruel sacrifices, independently of all prospect of esteem, respect, or remuneration. I am ready to grant this; but then it

* The author, in this and the two following paragraphs, seems to have adopted the doctrines of Helvetius, rather than exhibited the inferences naturally following his admission of the brain being a congeries of organs devoted to the exercise of the intellectual faculties, the affections, and the propensities. Warriors, artists, diplomatists and literati, have a direct, immediate pleasure in obeying respectively the impulses of their inherent faculties of love of battle and bloodshed, of colours and external forms, ambition and causality, or following out a series of mathematical inquiries, —all distinct from and independent of any subsequent conversion of toil, exposure or deprivation to the purposes of personal aggrandizement, or family settlement and emolument. There is no conceivable proportion whatever between the intensity of application of a mathematician, for example, and his ardour for discovery, or love of praise, and eagerness to acquire renown. Where vanity or ambition prompts to unusual and continued intellectual exertion without the gift of genius or inherent talents being allowed to the individual, insanity, not renown, is his reward. As no man can be reasoned into ambition who has not this sentiment by nature, so neither can a man acquire reasoning faculties by any and all of the incentives of ambition. Whoever doubts this, let him consult the history of genius in all ages; or watch for a single term the progress of a class of youths at college.—Trans.

must also be admitted, that the pleasure they experience, either in thinking they are about to make a discovery, or in making it, is the motive and compensation for their trouble and privations.

The fear of pain, and the prospect of pleasure, which are themselves pain or pleasure, are consequently always the motives for man's actions, and sufficiently explain the efforts he makes to resist the suggestions of the viscera—that is to say, the voice of instinct, which, notwithstanding this opposition, never ceases to solicit the centre of perception, and often overcomes the obstacles presented on the part of the will.

These phenomena are doubtless intellectual, since they imply the exercise of sensibility, which itself is purely intellectual;* but they are not more so than the pain or pleasure experienced in obeying the impulses of instinct, and in gratifying, without control, the wants of the viscera. All I see in these acts, in appearance unnatural, is the action of the centre of perception opposed to the influence of the viscera. Now, as the nervous apparatus of the hemispheres, from which we derive our intellectual faculties, and which act, in this case, upon the centre of perception, are in the brain, I can discover nothing more, physiologically speaking, in this resistance to our wants, than the action of one portion of the animal matter against the other.

When the centre of perception undertakes this resistance, the nervous matter which composes it, as well as that of the hemispheres which enable it to resist, is always in a state of vital erec-

* If sensibility be purely intellectual, it ought not to have been so often associated with instinct by the author. But, not only is it connected with this latter, but with what may be called automatic impulse. Suppose an impression made on a sensitive surface or expansion, in an animal of the most simple nervous organization; it is transmitted to the origin or root of this nerve, whence emanates, with the promptness of an electric shock, an aura or influence along another nerve, to some moving portion; as in the case of a worm, which touched with a pin, will writhe itself under the offending stimulation. Again, while a dog is looking at me, if I raise the cane in my hand, as if to strike him, the impression on his sense of sight transmitted to the brain, calls into action this organ; and the muscles of the limbs, in obedience to the instinct of self-preservation, are in rapid motion for flight. Finally, suppose a person, walking quietly along, sees another with uplifted hand ready to strike him; he raises his own arm in self-defence, and remonstrates with the assailant for his unprovoked violence. In all these three cases we have only one common process, viz. sensation, allied, in the first, with mere contractility; in the second, with instinct; and in the third, with intellect. Sensibility, evidenced as it is by sensation, cannot then with propriety be called purely intellectual.—Trans.

tion,—in other words, its contractility is augmented—fluids are attracted to it, and the phenomena of vital chemistry are carried to excess. These are facts which should never be lost sight of by the medical physiologist, in his attempts to explain the causes and phenomena of diseases.

Let us now endeavour to discover the origin of those abstract ideas through the agency of which the centre of perception resists the influence of the viscera. In order to do this, I shall investigate the impressions of those bodies which do not appear destined to gratify our wants, in the same way as I examined the impressions of those which are in close connexion with them. The former, as well as the latter, constitute the source of the abstract ideas on which are founded, pride, self-love, courage, compassion, &c. The sight of the sky, the earth, a field, an edifice, an instrument the use of which is unknown to us, a book, a table, a mathematical proposition, a hieroglyphick, the characters of an unknown language, the sound of thunder, or of a torrent, the notes of a bird—all make upon us impressions which very often do not appear to act on the viscera, and consequently do not serve to interest our instinctive operations. Hence we might, perhaps, be tempted to regard them as limited to the sense by which they are received, and to the brain to which the latter transmits them. A little reflection, however, will suffice to show, that they are much more extensive than they appear at first sight. In fact we may conceive in man the existence of a state, during which these impressions will act powerfully on the viscera: thus the aspect of the sky will excite emotion in an individual long deprived of it,—the mariner after a tedious voyage will be rejoiced at the sight of land,—an unknown instrument may arouse our curiosity, and produce in us agitation, if we suspect that it can serve for the gratification of a want, or cause our destruction,—a stone which is about falling may make us start with fear, and one from which, when shivering with cold we expect to draw fire, may cause us to leap with joy,—a book will occasion the same effect in a man devoted to study, devoured by ennui,—a table on which one of our most urgent wants is ordinarily gratified, will excite in us a return of the sensation of hunger,—the sound of thunder gives rise to fear in a timid person,—that of a torrent grieves the fatigued traveller, who by this obstacle finds himself separated, for a long time, from the object he is

interested in attaining, &c. It is almost impossible to conceive the existence of an object in nature, which may not be found intimately connected with some one of our most urgent wants. The sight of a man who gratifies the desire of urinating is very indifferent to the one whose bladder is empty; but under other circumstances, this want, to which no attention was paid, is keenly felt. Hence, it may be plainly seen, that I could greatly multiply these examples, and prove that the sight of a hieroglyphick, an arithmetical rule, and even the characters of an unknown tongue, may be the cause of acute sensations, referrible to the viscera. Now, is not the impression in all such cases judged differently from what it would be were we to experience nothing in the interior of our organs? The viscera are consequently consulted on those impressions that do not seem linked to our first wants, as well as on those which have with them the most evident connexion;—or rather all impressions are connected with these wants.

It may, perhaps, be said, that it is only the conclusions drawn from these impressions, that agitate the viscera. Well; these conclusions are abstract ideas; hence abstract ideas are, like many others, in a state of relation with the viscera. But, in the emotions in question, reflection does not always intervene; for example, the visceral movement, as that experienced on seeing the approach of a stone about to strike us, is often executed with so much rapidity, that it cannot be the result of reflection, but must be referred exclusively to instinct.

It may also be said of the impressions produced by these bodies, what was before remarked of those occasioned by aliments, difference of sex, &c. "These impressions are judged of by the brain, independently of the viscera; and if, when very powerful, they are transmitted to the thorax, abdomen, or skin, this constitutes only a secondary phenomenon, producing no other effect than that of rendering the action on the brain more considerable."

To this I answer—Doubtless the brain, when it makes us judge that a sheet of paper is white, or dotted with black letters—that it is square and smooth—that an oak tree is larger than a reed—that one body is farther off than another—that a sound is acute or grave—that a metal is hard, and wax soft—that water is liquid and moveable, whilst ice is dense and firm—that a man reasons correctly, whilst another raves—that a whole is more considerable than a part

—that an effect implies the existence of a cause—that two and two make four, &c.—when the brain makes us judge of these facts, I repeat, it is not guided by the influence of the viscera, since these are purely intellectual operations. But, at the same time, that the brain is acquitting itself of these operations, the nerves of the other viscera are agitated, though they do not appear to be so; or in other words, the organic movements of the cerebral substance are at the same time propagated to the whole nervous apparatus of relation, and even to that of the internal functions, in the same manner as when the brain reacts upon the impressions resulting from an aliment, from the sight of a wished-for female or male, from the voice of an enemy, &c.; and if the propagation of these movements do not cause sensations referrible to the viscera, it is because there is nothing in the idea capable of interesting them. As soon, however, as a connexion of this sort exists, the modification of the viscera becomes appreciable, either by a sensation or by a movement. As we are on the subject of impressions in general, I shall select, for the purpose of illustrating the foregoing remarks, an example already cited. A man sees another make water; if his bladder is empty, he feels nothing in that organ; if, on the contrary, it is full, he experiences a sensation which invites him to follow the example of the other. In the latter case, the propagation of the cerebral irritation to the bladder is proved by the evidence of the senses; in the first it is not so, but it may be demonstrated by means of induction. Thus, if the impression made on the brain were transmitted to the bladder when full, and not when empty, its mode of action would not always be the same. Now, we cannot admit two different modes of the same impression; consequently, if in one case it is transmitted to the bladder, it must be also in the other, and the only difference will consist in the manner in which the bladder is modified by it. In both instances, the impression is the same in reference to the organ of sight, and to the brain; since it always consists in the perception of a man making water;—but in the one, the bladder, feeling no interest in the idea, transmits nothing to the brain; whilst in the other, the contrary being the case, it solicits the centre of perception, by making it experience a sensation.

The same occurs in respect to all the other organs capable of transmitting the sensation of a want; but I have selected the bladder, because I have already spoken of the other internal senses. They are always modified by the ideas which stimulate our brain;

but when they are not in that condition in which they can give the sensation of a want, they do not transmit it to the brain, even though our attention is fixed upon objects capable of interesting them; whilst, on the contrary, if they are in that condition, they never fail to give rise to this sensation.

But we may go even farther, and prove, that although the viscera do not always transmit to the brain sensations relative to nutrition, depuration, generation, &c. they still send others to it, during the exercise of the intellectual functions. It is under these circumstances that we can appreciate to what degree the exercise of thought agitates the whole of the nervous system. What appears very remarkable is, that all the viscera do not respond in an equal degree to the stimulations of thought. Every time we are excited in discussing a question, even the most abstract, and consequently foreign to nutrition, &c. sensations and movements are developed in the stomach, lungs, and heart; the skin becomes hot or cold, red or pale, relaxed so as to allow the passage of perspiration, or contracted, so as to straiten the hair, &c. It is the passion of self-love which is manifested; it doubtless originates in the brain, but it is increased and nourished by the sensations which the latter perceives in the different tissues. This is so certain, that if the viscera be in a state of irritation, either from the effect of wine, or from the existence of an inflammation, the sensation perceived in them is much more lively, self-love more excitable, and the transports of this passion incomparably more violent; whereas it is scarcely marked, if the stomach, the principal seat of the visceral perception, be cooled by water, or any other sedative agent. Now, this self-love is itself founded on a want. Agreeably to my view of the subject, its basis, as well as that of anger, vanity, fear, horror, compassion—sorts of modifications of our consciousness, which are equally observed in the exercise of the intellectual functions,—is the instinct of self-preservation.

It is in this way, that the most abstract ideas, as those of the beautiful, the great, the regular, the sublime; of virtue, vice, justice, oppression, tyranny, and all the most subtle ideas of comparison between the qualities of bodies,—in a word, all that constitutes the immeasurable domain of human intellect, are linked in the most intimate manner with the nerves of the viscera, and exert an influence on the organic movements of their different tissues.

It will perhaps be objected, that these passions are only developed

when the intellectual operations are exercised with the greatest degree of energy; and that the viscera, by which they are nourished, are not in the least degree affected when the mind acts quietly; but this opinion is erroneous. If the brain did not diffuse the irritations it undergoes, through the viscera, the latter could not respond to it and recognise the ideas which may interest self-preservation or any other instinctive want. The proof that they participate in these irritations, is, that they are agitated, and very actively too, when the intellectual operations are exercised in even the calmest manner. A man is very quietly occupied in his library with abstract ideas,—with a mathematical problem, for example—the image of his rival offers itself to his mind, and he instantly experiences pain in the epigastric region,—his heart is agitated,—his colour changes, he experiences the transports of a passion; it is emulation, jealousy, envy, &c. But even such motives are not necessary; for it is sufficient that he should experience some difficulty in solving his problem, to cause him to be irritated, and his self-love to be revived. If he calculates with facility, he experiences a pleasure, which is equally felt by the viscera, especially at the epigastrium, and stimulates him to further efforts. Now, let me once more ask, how could all this take place, if the viscera were not always ready to respond to the intellectual operations? If they are ready to do so, how could this be, were they not agitated on the occasion of the excitement which the brain experiences during the most tranquil exercise of thought.

It is therefore very certain, that the nervous apparatus, even that of the viscera, is modified by intellectual operations.* This ques-

* This remark is worthy of especial attention, since its application so intimately concerns the health, and even comfort of the studious literati, and of all those addicted to much and profound meditation. We regret that the author did not present the fact with its simplicity of physiological explanation, divested of metaphysical hypothesis. There is no necessity for the intervention of the passion of self-love to cause a commotion in the viscera, consequent on the exercise of the intellectual faculties. In admitting the correctness of the language of the text, that "all that constitute the immeasurable domain of human intellect are linked in the most intimate manner with the nerves of the viscera, and exert an influence on the organic movements of their different tissues," the explanation is most simple and ready. The anterior portion of the cerebral hemispheres, that on which depends the performance of the functions purely intellectual, is in these cases strongly and fixedly excited, and this excitation is transmitted to the continuous parts of the encephalic apparatus, and from its basis passes by means of the spinal marrow and nerves to the viscera. It is in this way that prolonged thinking and meditation, however calmly conducted, and free from every personal feeling of

tion is not purely speculative; its solution is indispensably necessary towards forming a correct idea of the relations, and explaining the powerful influence of intellectual labours on the health. We shall soon examine it in this point of view; at present it will be of service to us in establishing the distinction between the intellectual faculties and the passions, and in determining the physiological nature of the latter. (I.)

Section V.—*Of the Passions.*

Patior, I suffer, or more generally, *I feel;* in other words, I experience pleasure or pain. This is the idea of the passions. But it cannot occur unless sensibility be roused, or unless the brain execute the intellectual operations. Has Bichat been too exclusive in circumscribing the passions to the viscera? This very ingenious author perhaps thought it sufficient to say, that a man feels, in order for all to comprehend that his brain is in a state of action. Did he only mean, that the sensations which accompany the passions are felt in the different viscera? If such was his meaning, I think he was perfectly correct; but I also think he was wrong in asserting that, during the exercise of the intellectual faculties, sensations were felt only in the head, since from what I have said, it results, that the intellectual operations are not executed without a mixture of passions, or at least of affective sensations. His great error consists in having, in general, too much separated the passions from what are called *intellectual faculties*, or more properly *intellectual operations.*

In truth, our passions and our affections are a result of our intellectual operations; but the following are, according to my view of the subject, the conditions necessary for their existence. There can be no passion without a number of sensations referrible to the viscera; and all these sensations are founded on our wants, or, in other words, on our instinct.

In order to be convinced of the truth of this assertion, it will only be necessary to pass in review the principal divisions

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self-love or ambition, keeps up an irritation in the digestive and pulmonary apparatus, which is but a reflection of the prior one, or vital erection in the cerebral organs at the anterior part of the encephalon.—Trans.

in which our affective sensations have been arranged. Let us endeavour to start from an incontrovertible principle, namely—*all our sensations are reducible, for the physiologist, to pleasure or pain.*

Our affections are founded on our sensations, and the former sometimes degenerate into passions. When we experience pleasure, we are cheerful; whereas, when we feel pain, we are sad. Cheerfulness and sadness are often produced,—the former, by a good state of health,—the latter, by a contrary condition. The state of health exists, when the organs execute well their functions, without being too much or too little excited;—this is the natural state of our economy. The diseased state, on the other hand, occurs when the organs are too much or too little excited;—in other words, when the natural state is interrupted. The latter is maintained or disturbed by many causes, which we can only examine here in a general manner. For our present purpose, we must divide these causes into two grand series;—the one physical, the other moral. Physical causes give rise to what are called *physical* pleasures and pains; whilst moral causes occasion *moral* pleasures and pains. The latter series are felt by the same organs as the former; consequently, for the physiologist, these feelings are all physical, since he always perceives in them a modification of the living tissues. Wherefore, then, do we admit moral pleasures and moral pains? Because we have regard to the cause by which they are produced. When this cause consists in the exercise of our intellectual faculties,—in other words, in a result of thought, we call it *moral;* consequently, by moral pleasures and moral pains, we understand a state of contentment or uneasiness, perceived in the viscera by the centre of relation, during the exercise of thought, which, as we have seen, is always accompanied by a modification of the organs,—a modification which is nothing more than a state of irritation. But, on the other hand, the physical modifiers, such as air, light, heat, or cold; foreign substances deposited on our internal surfaces of relation; and all those bodies which have occasioned a solution of continuity in our tissues, excite in our organs a state of irritation, similar to that produced in them by moral causes, and thus give rise to the perception of physical pleasures and pains, analogous to like sensations produced by moral causes. Let us now see how these considerations will lead us to a knowledge of the affective movements, and of the passions.

We love the causes of our pleasures, and hate those of our pains,

whenever we can discover them; but, we cannot love or hate, in an equal degree, nor in the same manner, physical and moral causes. Thus, even were we positively assured, that cold, heat, certain indigestible substances, or bodies which wound us, are the causes of the pain we suffer, we could never entertain towards them the same feelings of hatred that we should experience towards a person who had furnished the moral cause of our sufferings. We only experience for cold, heat, or the instruments by which we have been wounded, a feeling of aversion; and for the aliments or odours which are agreeable to our senses, a relish more or less keen; but neither of these sets of causes excites in us what is denominated a passion. In respect to the moral causes of our pleasures and pains, they may likewise inspire us only with a slight feeling of affection, aversion, or disgust; but these causes, or, in other words, the individuals from whom we derive pleasure or pain, are sometimes also the object of a violent passion, either of love or hatred. It follows, therefore, that even were we to discover the physical causes of our pleasures and of our pains, they could never be the object of a passion. But it often happens, that we are ignorant of them, and under such circumstances, our dislike or our fondness,—our hatred or our love, are often directed towards the individuals by whom we are surrounded, as if they were the moral causes of our sufferings or of our pleasures. Moreover, although we may be apprised of the physical causes of our pleasurable or painful sensations, it is often noticed, that instead of directing towards them our hatred or our love, we select, as objects of the one or other of these passions, the individuals with whom we have been, or still are, in habits of intercourse.*

* There is abundant matter, in these two last sentences, to furnish text for a volume of ethical commentaries. The author, whatever time shall prove to be the extent of his merits in other questions of physiology and medicine, deserves the gratitude of his fellow men, for presenting in such a variety of points of view, and in such strong colours, the modifications imprinted on the mind by the condition of the viscera. The impressions produced on the surfaces of relation, and the sensations and thoughts ensuing therefrom, will give but a very imperfect measure of the state of the mind, if we are ignorant of the irritations affecting it, from the body generally. Charity then receives, in a knowledge of the many internal causes of irritability, an additional motive for making large allowances for transient petulance, inconsistency, and angry resolve. Morals can never be efficiently taught without a full knowledge of the agents of hygeine, and of all the stimulations emanating from the viscera and received by the brain —TRANS.

Consequently, our affective movements, and our passions, which have always for their objects individuals of our own species, may equally arise from the action of physical or moral agents. Yet, whichsoever of these causes produces them, our affective movements and our passions suppose always an irritation of the viscera, causing pleasure or pain, and the actual exercise of the faculty of thought, by which we are enabled to perceive the one or the other. It results, moreover, that these states of feeling may be kept up or destroyed by the modification of thought, as well as by that of the irritation of the viscera. Thus, if the series of ideas be changed, by means of new impressions, when the affective movements and the passions are excited by moral causes, the brain will no longer keep up the irritation of the viscera, the pleasure or pain of which gives rise to these states; and, on the other hand, when they are the effect of the irritation of the viscera, produced even by a physical cause, if this be removed, it will no longer direct the thoughts towards the series of ideas which contribute to nourish the affective movements, or the passions. It is easy to conceive, however, that such cures cannot take place, if, in consequence of its intensity, or its continuance, the physical irritation which maintains the existence of the passions, has destroyed for ever the healthy organization of the seat of thought, which is the brain, or that of the organs in which it perceives pleasure or pain,—that is to say, of the other viscera. But this new truth is only an additional proof of the correctness of our assertion.

By the foregoing observations it is seen, that I apply the name of *affective movements*, or simply *affections*, to those feelings of love or hatred which are but transient, and do not derange, in a continual and dangerous manner, the natural state of our economy; whilst I reserve the name of *passion* for such of these feelings as are violent, enduring, and imperious;—which enslave and become the real tyrants of our intellect,—serve as the excitors of almost all our actions, and threaten, in a greater or less degree, the integrity of our organs.* In reality all these feelings are of the same

* The term *passion* has been, as we think, very appropriately restricted by the phrenological school, to express the exalted or morbid action of a propensity or sentiment. It does not properly indicate an innate quality of mind, but merely an occasional mode or manner of its manifestation. Thus self-love is an innate sentiment, which within proper bounds gives dignity to its possessor. But when acquiring more energy and indulged in all its impulses, it degenerates into the passion of pride and becomes imperious and repulsive. So of courage, firmness, hope, cautiousness, &c.—Trans.

nature; since their seat is the same, and they are equally founded on pleasure or pain; but they differ sufficiently in respect to their intensity and consequences, to justify us in dividing them into two series.

The first of the passions,—that from which all the others emanate, is self-love. It is founded on the instinct of self-preservation, and on that of the propagation of the species; for both are blended together; and this instinct, which is often disguised, is kept up by the pleasure we have in feeling that we live. All that makes us actually experience this pleasure, and affords us the prospect of again experiencing it, is loved;—all that produces the contrary effect is hated,—unless indeed the intellect has created for us moral motives for feeling otherwise; but as I have already treated this question, I shall not recur to it in this place. I shall content myself with remarking, that when we think we are the objects of our hatred, we still love ourselves. It has been asserted that this explanation destroys every principle of morality; but than this, nothing is more false. Of what import is it, when we do a meritorious action, whether it be or be not on our own account?* Is it the less useful to society? We must not indeed apprise all men of the secret mo-

* This is not perhaps either the most prudent or the most philosophical manner of presenting the question. To say "that whatever contributes to the welfare of individuals, contributes, in like manner, to that of the whole species," is a proposition demanding large reservations and a somewhat elaborate explanation. It would be safer for us to invert the maxim, and to advance that whatever contributes to the happiness of the whole species, contributes *generally* to the welfare of individuals. We say generally; for at times a sacrifice of the individual seems to be required for the good of society, and that without any crime or notable misdemeanour on his part. The moral harmony is thereby cherished just as the harmony of creation is sustained by occasional destruction. But conceding that individual gives social happiness, we are always forced to admit that a person in quest of this blessing cannot hope to attain it, unless he act on data, derived not merely from his own first instinctive wants or the suggestions of self-love and vanity, but also from the other innate faculties and external circumstances creating and sustaining his intercourse with his fellow creatures and society at large. All of a man's actions are in one sense resolvable into self or personal gratification, since all are the result of feelings and motives personal to and inherent in him. But these feelings and motives are various, often balancing, if not conflicting with each other, and susceptible of being modified in a most opposite manner by foreign or external agencies. Hence, we cannot agree with the author that self-love is the first of the passions, that from which all the others emanate. Helvetius, in his work *De l' Esprit*, while adopting this principle, and endeavouring to show its applicability and correctness, has, we think, carried it, very unintentionally of course, and with great gravity, *ad absurdum*.—Trans.

tives of their actions, because some false and vicious minds would draw deductions from them unfavourable to social order. But it becomes the duty of legislators, who are aware of this motive, to place man in such circumstances, that it shall produce all that is good and useful to mankind; for they must be aware that whatever contributes to the welfare of individuals, contributes, in like manner, to that of the whole species. Let them create such motives of action as will prove of general utility, and let them do so either by means of their laws, or of habits which men shall contract from the earliest periods of life, and which will become the foundation of their morals; but let them not interdict us from telling the truth to those who are able to comprehend it. As respects myself, I willingly abandon to philosophers all profound discussions on the subject, and content myself with considering the passions in their relation with the organs, the functions of which they may, more or less, contribute to derange.

Our passions are, as we have just seen, susceptible of a grand division. Some are founded on pleasure,—others on pain; but as pleasure and pain may succeed to each other in the same passion, it follows, that we may form a third class, which we shall denominate *compound* or *mixed passions*. Joy is a state of pleasure which may originate from a variety of causes, either physical or moral, and which in this way is allied to all the passions founded on pleasure; but whatever may be its effects on the system, I cannot view it, properly speaking, as a passion. The words *contentment, satisfaction, happiness,* only express modifications of joy, or of that sensation of well-being, which accompanies all the passions founded on pleasure. However this may be, joy, contentment, satisfaction, happiness, all are founded on agreeable sensations which we perceive in the viscera, and which can only be felt when the latter are not in a pathological state. The causes of these sensations are either moral or physical; the former may, it is true, *tend* to produce them, but they cannot succeed in giving rise to and maintaining them, so long as the viscera are painful.

At the head of the passions founded on pleasure, we find sexual love. The organs which nourish it are those of generation, in which are experienced the most keen sensations. The passion of love supposes always the action of the intellect, for representing the image of the beloved object; and the action of the genital organs, for furnishing the sensation of pleasure, which solicits the centre of

perception to revert unceasingly to the idea of the cherished being. In order to demonstrate the coincidence of these two actions, it is only necessary to remove the genital organs, or to occupy the centre of perception with another series of ideas; for, under these circumstances, the passion is annihilated. Hence the instinctive want, on which the passion of love is founded, is that of propagation; when this want acts feebly, or transiently, or when felt indiscriminately for every individual of the other sex, there is only a general fondness or propensity, more or less marked, for the act of generation; but the passion does not exist. Nor even should we apply this term to the warmest transports experienced during the union of the sexes. But when an individual sees and desires but one single object,—when its image every where pursues, and unceasingly haunts him,—when grief, anger, and jealousy, are easily elicited, in consequence of the slightest obtacle to the possession of the beloved object, love is transformed into a passion. It is now easily perceived, that this passion, although originating in the want of a pleasure, becomes compound or mixed, whenever it attains a certain degree of intensity; because the agreeable sensation, in which it is founded and nourished, is interrupted by painful passions.

After love, properly so called, we find another passion, which is in like manner founded on pleasure, and is the sequel and consequence of the former; I allude to the love of offspring. This passion is not nourished by the sexual organs;—the sensations which maintain the brain, or rather the centre of perception, in the condition for sustaining it, reside in the thoracic and abdominal viscera; hence the expression of *paternal* or *maternal bosom*. The different seats of this passion may be demonstrated in a similar manner as those of the preceding one; and this demonstration, which we are about to give, will show, that this passion, like love, is founded on an instinctive want. And first, the part which the brain plays is evident, since to love our offspring it is necessary to think of them. The influence of the other viscera becomes conspicuous in animals, since by calming the organic action in the abdomen of a hen, by plunging it several times in cold water, or else by depriving her of her chicks, and confining her with a cock, for the purpose of exciting the genital organs, she will become unconcerned about her young. As soon as a cat, which manifested the warmest affection for her kittens, experiences the desire

of copulation, the condition of her viscera changes; the vital action is diverted, by the turgescence of the genital organs, from the digestive viscera and lacteal glands; her kittens become troublesome to her, and are driven away. In animals, love for the young has always a natural limit, and continues only until the latter have attained that period of life, at which they are capable of providing for their own wants. In this passion I discover two visceral elements: the first, among the females of mammiferous animals, is the want of getting rid of the milk, which supposes at the same time the existence of an irritation in the breast, and in the digestive organs;—the second element, among the females of birds, and the males of certain species, is the sight of the young: so long as these are weak, their presence excite sensations of affection, compassion, or love,—whence result the acts necessary for their alimentation, and their defence; but when they become strong, these sensations disappear. In what portion of the body does the brain of all these animals perceive such sensations? Judging from our own species, and by induction from those animals that suckle their young, I should be led to admit, that it is always in the other viscera, and particularly in those situated in the abdomen. It will, perhaps, be asked, how these instinctive sensations can take place? To this I will answer, that they are not more difficult to conceive than all the others which I have already enumerated; and I will add, that they are precisely of the same nature. It is the will of the Creator, and the sensations transmitted to the brain by the viscera constitute the means he employs to execute it.

In an example drawn from animals, we have been able to discover the source of the love of offspring, in an instinctive want. If we endeavour to apply these remarks to man, we first find, that the same passion in him has the same organic source; and next perceive, that the intellect, reason, in a word, all the intellectual operations, transform this want into one of the most imperious and lasting of the passions; and this sort of demonstration should suffice. In order, however, to confirm the correctness of these remarks, we shall add, that women, being, like the females of mammiferous animals, subjected to the want of lactation, must always be more easily moved at the sight of their children; and that, consequently, their attachment to them must be much more powerfully felt in early infancy. And, indeed, experience teaches us, that such is the fact. In general, man, although sharing with all warm-blooded animals,

the feelings of compassion excited by the presence of a being of their own species, feeble and requiring their assistance, becomes more attached to his children when they have grown up; while the mother, on the contrary, loves them most when they are young; consequently, maternal love is more instinctive and physical, and paternal love more intellectual and moral. I hope, however, that this assertion will not be carried beyond just bounds; for I am happy to admit, that women, who are also endowed with intellectual faculties, must have the same causes for loving their children when they have attained the age of reason and maturity, as those which increase and justify the tenderness the father then extends towards them. All I mean is, that woman is by nature more impelled than man, to cherish the fruit of her love. Doubtless, also, the trouble, and the cares her children have cost her, contribute greatly to increase her affection for them; for it is a fact, which cannot be denied, that we feel an attachment for all persons to whom we have been happy enough to render any service. It is thus, that moral are joined with physical causes, in order to procure to our species those passions, which of all others afford us the sweetest enjoyments and the purest happiness. In fact, the passion of the love of offspring is not, like sexual love, necessarily subject to a mixture of painful sensations, unless, indeed, they originate from causes in their nature totally foreign to that passion.

The love of one's children, when freed from the instinctive impulse, which only continues so long as they are young and weak, is henceforward only maintained by purely moral motives. The passion is allied, therefore, at this period, to all the attachments which are not founded on the prospect of physical pleasure; and all that is most powerful and delicate in it, is purely moral. It originates in the first place from our self-love, which is reflected on our children, and from the good qualities we attribute to them, and of which we are proud to be the source.—It arises in the next place from the community of interest between them and ourselves—from the reciprocal attachment they bear to us, and finally, from the need which we foresee we shall have of their assistance, when our faculties begin to fail, and make us feel all our weakness. It is by similar motives that the bonds of friendship are cemented; for it is always the moral pleasure resulting from our intercourse with another individual—the services we may obtain from him, or those we have rendered to him, and which flatter us with a return founded on

gratitude, that attach us to our friend. We experience, it is true, at first sight, an inclination, or, as commonly expressed, a sympathetic feeling for certain individuals; but this sympathy, which is purely instinctive, is only changed into friendship in consequence of our intercourse with them, whereby we discover the motives for those moral enjoyments I have just alluded to. This instinct by which one individual is attracted towards another, we possess, in common with many of the gregarious animals; it is true that it constitutes the foundation of the passion of friendship, but it is not friendship itself.

Friendship, then, such as we must conceive it in our species, is a purely intellectual passion; but this does not prevent it from being attended with sensations referrible to the viscera, such as exist doubtless in animals; for all the emotions it procures us are referred to the epigastrium and heart, and thence extend to the whole sensitive apparatus. The part which is played in this passion by the viscera, is moreover shown by their diseases, which sometimes occasion a complete change in our friendships. I have often seen individuals labouring under gastritis, as well acute as chronic, express a dislike for the persons they loved most, prefer others, and return, after recovering their health, to their first inclinations. In others, this phlegmasia destroys all the affections, produces misanthropy, which may be pushed to a horror of life, and even to a desire for death. After a consideration of these facts, how can we refuse to admit, that the brain is not always free in the exercise of the intellectual faculties?—But let us not anticipate here what we have to say on the subject of the painful passions.

Pride and vanity are two modifications of *self*, which are very analogous to each other; they are both founded on the pleasure we experience in comparing ourselves with others; because this comparison furnishes us with motives for increasing our self-esteem. We then greatly enjoy our existence, and gradually accustom ourselves to search continually for opportunities of repeating this comparison: finally, this enjoyment is converted into a passion; since we become irritated against every obstacle by which we are prevented from experiencing it, and hate every individual from whom we meet with opposition. Pride differs from vanity in being founded on motives of a more elevated character, and in being often justified, at least in the eyes of the generality of men, by titles which have been acquired to their regard and respect. Vanity,

less difficult to please, is nourished by trivial things, and consequently finds a greater number of pleasurable and painful motives; but they are less acute than those of pride, and give rise, therefore, to movements less violent and perturbating for our organs. These passions are common to both sexes. Pride is much oftener met with in man; whereas, vanity is more frequently the portion of the female sex: both passions are the effects of civilization. The pleasurable sensation which nourishes them, does not at first appear to have a well defined seat in the viscera; but when it becomes exalted, it is distinctly felt at the epigastrium;—the heart seems to be enlarged,—it propels the blood with greater energy;—the face becomes red,—the eyes sparkling; and the action of the voluntary muscles appears to be increased. The sufferings of the principal viscera prevent the developement of these passions, and rather produce a feeling of humility, by making us sensible of our weakness, and leading us to comprehend how unstable are the foundations of the motives of the pleasure we experience in comparing ourselves with others. These passions are much exalted in early life; are subsequently diminished in proportion as we feel our weakness increase; and finally disappear, together with all the others, when we foresee the approaching termination of our existence. In these last cases, pride sometimes degenerates into vanity; hence this passion is very often the portion of old age, and constitutes the principal moral enjoyment of which it is susceptible.

Self-love, viewed as a moral affection, is a feeling the nature of which is nearly similar to that of the preceding ones; but its motives are more plausible, and do not always imply the weakness of judgment discovered in vanity; there is, therefore, but a shade of difference between them.

Honour is another feeling, which, like the preceding, is founded on self-esteem. It commands us not to do any thing likely to be disadvantageous to us, when we compare ourselves with others; it is a kind of self-love or pride, the motives of which are worthy of unlimited praise, since they induce us to perform actions useful to society. Often it is founded on less plausible motives; as for example, when we make honour consist in supporting a bad cause, merely because we have already declared ourselves its defender, &c.: but it is clear, that the abuse of a thing is not the thing itself; and that true honour, or that founded on good motives, is nevertheless, a very fine and elevated feeling. Emulation is nothing

more than this same desire of obtaining an enjoyment by comparing ourselves with our fellow men. Ambition, and the immoderate desire of grandeur and riches, which must not be confounded with avarice,—since opulence is sought after merely for the purpose of ostentation,—appear to me to be founded on sensations of pleasure analogous to those that give rise to pride, &c.; their seats are the same, and they differ only in the means that are used for attaining the enjoyments of the comparison. I shall, therefore, not enlarge any more on the subject.

From the preceding observations it follows, that the words *pride*, *ambition*, *emulation*, *honour*, and *vanity*, express modifications of self-love, consisting in the pleasure we derive from the comparison of ourselves with others. Whenever this sentiment of pleasure becomes a want, towards the gratification of which the greater number of our actions are directed, it is converted into a passion, and gives rise, when exalted, to pungent sensations in the viscera, and to very violent organic movements, which are agreeable so long as no obstacle is offered to their enjoyment. Is the feeling of self-love peculiar to the human species? However this may be, it is very certain, that we notice in many animals actions which lead us to think they are susceptible of emulation. Thus it appears to us that a horse is influenced by the point of honour, and redoubles his speed in order not to be passed by another of his species. The same remark has been made in relation to the dog. If one of the rivals be surpassed by the other, he loses courage, in the same manner as man; and in the midst of his humiliation, does not even display the efforts he might have done had he not attempted to contend with a competitor. Is it a motive of self-love analogous to that of our species, which serves as the exciting cause in these animals? Is it not rather the simple and powerful law of imitation, which impels them to undertake this kind of spontaneous contest? In order to settle this question, it would be necessary to place ourselves in the situation of the two rivals;—this, however, is impossible; but as we discover so many proofs of intellect among animals most nearly approaching to our nature, we can hardly hesitate to consider them as susceptible of a certain degree of self-love, although we may admit, that its motives are different; since animals are deprived of that reflecting faculty which constitutes the distinctive mark of the human species. If we concede self-love to animals, it will be necessary to attribute it to their instinct; and in that case we should

discover the source of that passion, as well as of all those we have hitherto examined as they appear in ourselves, in our instinctive faculties,—or, in other words, in the wants of our viscera. We should afterwards perceive our intellect, developed under the influence of civilization, impress on self-love its peculiar stamp, and render it susceptible of assuming those different shades or modifications which we designate by the words *pride*, *emulation*, *honour*, and *vanity*. This manner of viewing the subject appears to me the more plausible, as these shades of self-love are unknown to men who live in a savage state, and who even have not, in their rude language, expressions capable of conveying the least idea of these sentiments. Should any one entertain doubts on this subject, let him consult the writings of travellers, and more particularly a work entitled *Recherches Philosophiques sur l'Origine de la Pitié*, by M. le B. de B.

There exists, in the greater number of animals, an urgent want, of which I did not speak under the head of instinct, but to which I alluded indirectly when examining the acts depending on it; I mean the want of locomotion. It is very imperious in young animals, because exercise is absolutely requisite for the developement of their organs. It is this want, which, when seconded by the feeling of well-being resulting from health, excites in them that cheerfulness we observe in all those whose organization is allied to our own. It is manifested by a fondness for play, for leaping, and even for violent exercises, without any very evident motives, and from the most trivial causes. It is owing to this propensity, that a kitten gives us occasion to admire its dexterity, its supleness, and the gracefulness with which it amuses itself with objects susceptible of a certain degree of motion. We discover in it that instinct which will lead it in future to spring on the prey it is watching, so soon as the latter makes the least movement with a view to escape. The want of muscular exercise is not less evident in children; it is founded on the pleasure they experience in exercising their growing strength; it becomes converted into a true passion; since the prospect of enjoying it gives rise in them to violent transports attended with agreeable sensations in the viscera; and if they are deprived of it, they become sad, and their health is in danger.

The want of exercise diminishes as we advance in years, and in old age it is replaced by the want of repose,—a certain presage of that absolute inertia which awaits us in the last days of our existence.

Such are, in my opinion, the principal passions founded on sensations of pleasure. It is true we discover other shades of affective movements, equally founded on agreeable sensations; but they consist in propensities and inclinations which are but rarely converted into passions. Yet, although this conversion is not common, we must endeavour to note it where it *does* occur,—as I shall now attempt to do. Among the affections alluded to, I place benevolence and generosity,—kinds of taste which impel us to do service to other men, because we derive from so doing a true enjoyment, which is not solely seated in the encephalic nervous apparatus. It is here necessary to draw a line of distinction. These acts may originate from pride or vanity; or, in a word, from that same self-love of which we have just spoken: under such circumstances, they must be referred to that passion. But there are many persons who do good for the mere pleasure of doing it, and without being led to it by the satisfaction of comparing themselves with others. By some philosophers it is asserted, that these individuals are influenced by the fear of falling into a situation similar to that of the unfortunate whose sufferings they alleviate; and it is to such a principle that these philosophers attribute compassion, commiseration and pity. These affective movements would, therefore, be founded rather on pain than on pleasure. But is it a well-established fact, that individuals, endowed with those precious qualities of the soul which we denominate *benevolence, generosity, compassion*, and *pity*, invariably reason in this way, previously to rendering a service: "Let us relieve the sufferings of this unfortunate man, for the misfortune which now afflicts him may one day happen to us; and perhaps from gratitude, he may be led to relieve us?" I cannot believe that such is the case. That some may reason in this way, I am ready to admit; but that such a motive should invariably influence benevolent acts, I cannot readily persuade myself. It is alleged that this virtue does not exist among men in a savage state,—that it does not appear in the early periods of infancy, and that, consequently, it is only the result of the social state, which has insensibly accustomed us to appreciate the importance of reciprocal attentions and services. Our wants, it is further said, are so greatly multiplied by civilization: that our own powers being no longer adequate to their gratification, we feel all the importance of providing for ourselves, when occasion requires, the love and gratitude of our fellow men. I have no doubt that these

motives contribute to render us better than we are; but I cannot admit that the inclination to succour the unfortunate is not natural to man. Let us examine several children born of the same parents, and educated in the same manner. The greater number will be cruel; but among them will always be found some, who, although the example is daily set before their eyes, will appear reluctant to inflict pain on a being endowed with sensation; and it is but justice to remark, that these exceptions are more frequently met with among individuals of the female sex. The same must be the case with savages,—some good individuals are always found among them. The habits they acquire from their mode of life, must divert them from this inclination, and finally succeed, perhaps, in destroying it; but as it is written from all eternity in the heart of man, or rather in his intellect, that benevolence is in itself a good and laudable thing, so soon as you shall have civilized these barbarians, and they cease to regard ferocity and unmercifulness as honourable, they will yield to the example offered by those among them who possess this virtue, and the acts founded on it will become as frequent as they were before of rare occurrence. I have already said, that great public calamities, such as famine, the privation of all habitual enjoyments, the continual aspect of death, bring civilized men very soon back to egotism, and to the cold ferocity of the savage state. This, doubtless, proves that the majority are not good; but as amid these terrible circumstances there have always been found instances of generosity and self-denial,—as these examples have been lauded and admired even by those who did not discover within themselves sufficient resolution to imitate them, we must believe, that the pleasurable sensation attached to these noble actions, is really natural to man.

I have moreover said, that they depend on the exercise and developement of that portion of the encephalon destined to the intellectual operations, and that they indicate the triumph of the mind over instinct.* This is proved by facts; for the ferocious men,

* In looking around on our fellow creatures, and observing in many of them the warm, prompt, and spontaneous impulse to deeds of benevolence and generosity, without any hope of personal benefit and return, either immediate or prospective, we are forced to believe in the innate nature of these sentiments. While we admit that their manifestation depends on the encephalon, we cannot, however, agree with the author in saying that they are dependent on that portion of the encephalic apparatus destined to intellectual operations. If this were the case, the energy and cultivation

whom we have shown to constitute the majority, are always those who have cultivated in a less degree their intellectual faculties. Hence, benevolence and generosity are rarely converted into passions, because the latter are founded on instinct. When, however, these affections assume the character of passions, it is always owing to an influence of the brain over the viscera; because this influence possesses the property of producing in them sensations imitating those of instinct. In other words, the visceral sensations, the primary object of which consists in soliciting the gratifications of physical wants, may become so perverted, through the influence of the brain during the exercise of thought, as to induce us to sacrifice the pleasure of providing for our physical wants, to that of gratifying our moral ones,—that is to say, those that are purely intellectual in their origin. These remarks are very well adapted to display the intimate union which exists between the passions and the intellect, as well as that association of the viscera and of the brain, on which we have already so much insisted.

After having studied the passions founded on pleasure, we must next occupy ourselves with such as originate from pain. We must repeat here, however, that any obstacles to the pleasure which nourishes the passions we have just noticed, developes in us painful sensations. Hence, the passions founded on pleasure are rarely pure throughout the whole period of their duration; the pain which so often interrupts their enjoyment, rendering them almost always mixed, and leading us sometimes to select other expressions to designate them. It is thus that love, when it meets, in a rival, an obstacle to its enjoyments, assumes the name of *jealousy*. Love has many other causes of pain; they are, indeed, so multiplied, that it is sufficient to say of an individual, that he is transported with love, in order to imply that he necessarily experiences a mixture, or rather an alternation of pain and pleasure. The same occurs in all the pas-

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of the intellect ought to give the measure of benevolence and charity, which we know they do not. A Howard, and a St. Vincent de Paul, were not distinguished among their contemporaries for unusual compass of thought, and depth of research; nay, some of the most benevolent of men are remarkable for their very restricted intellect. We would say then, on the strength of general reasoning and positive demonstration, that the sentiment of benevolence is inherent, and we may add instinctive, and depends for its manifestation on the developement and exercise of a particular part of the cerebrum, different and distinct however, from that other portion which gives the faculties of intellect, such as of phenomena, comparison, causality, mathematics, painting, sculpture, and the like.—TRANS.

sions; for, from the mere circumstance that our affective movements have risen to that degree which merits the name of passion, it is impossible that our enjoyments should not be frequently interrupted by pain. Thus, the more anxious we are to enjoy, the clearer we perceive the obstacles which threaten to interrupt our pleasures, and the more susceptible we are of experiencing pain on this occasion. It is in this way, that the enjoyments of paternal tenderness, as well as those of friendship, self-love, emulation, ambition, pride, vanity, and of all the passions founded on pleasure, are constantly interrupted by painful sensations, which transform them into mixed passions.

Pain may be felt, although we are ignorant of pleasure; as may be exemplified in the new-born infant, whose first sign of sensibility is a cry of pain; but it can only be well appreciated by comparing it with pleasure, and it is from this comparison that it derives its distinctive character;—in other words, it is thus that it presents itself to our minds during the progress of life. Indeed, the passions founded on painful sensations, attain the degree in which we notice them, only because those who experience them have felt pleasure. What disgusts us with the causes of the pain we feel, is regret for the pleasure of which they deprive us. Were man deprived of this comparison, he would suffer pain without moral exaltation. He might, like the animal, become irritated against the cause of his sufferings, or struggle from an excess of pain without regard to the cause; but his anger would be of short duration, and would not amount to a passion; because, under such circumstances, he would only experience the physical pain; or rather he would not exercise his intellect in the comparison of the present pain with the past pleasure,—in the prospect of future pain, and of the privation of future pleasure. In this, in fact, consists the essence of the depressing passions. They are consequently all, at certain periods at least, like the cheerful passions, of the mixed kind; but as they have pain, for their exciting cause, without which they could not exist, I have constituted them into a separate class, which I have contrasted with the former.

The comparison of pain with pleasure constitutes, therefore, the moral cause of these passions; but it produces them only when there results from it a poignant regret for pleasure, and a continual fear of seeing it one day succeeded by pain. Consequently, I do not apply the name of *passion* to those painful sensations that are but transient,

even when they are produced by moral causes. I view them as *affective movements*,—varying in point of intensity,—but only assuming the name of passions when they become lasting and chronic. Having established this point, I now proceed to a consideration of the painful passions.

Grief is a painful condition of *self*, attendant on all kinds of suffering, produced either by physical or moral causes; it is, therefore, in reference to the passions founded on pain, what joy is to those based on pleasure. It is also designated by the name of pain. Sadness expresses, in ordinary language, the prolongation or chronicity of grief. We experience momentary grief; but sadness implies an habitual state of suffering, nourished by reflection. Sadness is therefore a passion. It may cease with the cause which produced it; but, when they are persevering in their action, sadness takes possession of our spirits;—we acquire, as it were, a fondness, and even a love for it, and we carefully avoid all impressions likely to divert our attention from it. Under such circumstances the passion is at its height, and all our actions are directed towards the accomplishment of one object,—that of prolonging the mixed state of pleasure and pain under which we labour.

Sadness is nourished by two sets of causes; first, melancholy thoughts;* secondl a painful sensation in the viscera, and principally in the nerves of the epigastric region; but, as these nerves are merely conductors, it follows, that the principal phenomena take place, on the one hand, in the nervous expansions and ganglia of the viscera, and on the other in the brain. The nerves, both cerebral and ganglionic, are the intermediate agents. In this passion, as in pleasure, the brain feels in the viscera the results of the melancholy reflections which arise in its own tissue, in consequence of the impressions made upon it through the medium of the external senses; and reciprocally, the irritations seated in the nervous expansions of the viscera, and particularly of the internal membrane of the stomach, having reached the brain, compel it to surrender itself to melancholy thoughts. Hence whatever may be the cause of sadness, it always implies the existence of a certain mode of irritation in the viscera. I say a certain mode of irritation, because that oc-

* They are not purely painful, as we distinguish in them, first, the recollection of pleasures past,—a recollection which is itself a pleasure. Secondly, the feeling of actual, and the anticipation of future pain,—the latter of which constitutes, itself, an actual pain. This sadness is therefore mixed.

casioned by a moderate dose of aliment will give rise to cheerfulness, whilst a more powerful dose will excite melancholy. If a proof of the necessity of the concurrence of gastric with cerebral irritation, in the production of sadness, be required, it will only be necessary to produce a gastritis, by means of stimulating *ingesta*,—for then the individual will be harassed by melancholy thoughts; whereas, by giving rise to the latter by a direct action upon the brain, through the medium of the senses, the individual will soon be affected with a certain degree of gastritis. By reversing the question another proof of the fact will be obtained. Whenever gastritis is the sole cause of melancholy, the latter will disappear so soon as the former disease is cured. If we remove melancholy thoughts, when they constitute the sole cause of sadness, the gastritis will disappear, provided it has not attained the degree of organic alteration.

I have selected gastritis with a view of proving the reciprocity of action existing between the viscera and brain, as being the most ordinary cause or aliment of sadness. I could, however, with equal propriety, have selected other examples, as peritonitis, hepatitis, pneumonia, and pericarditis; because in these inflammations, the serous surfaces and the parenchyma have acquired a degree of irritability equal to that of the mucous membranes, and may, consequently, give rise, in the nervous apparatus of the viscera, to that painful state which accompanies gastritis, and which in all instances is a natural cause of sadness. Yet, it must be confessed, that these inflammations necessarily give rise to it only when acute; for when they have attained the chronic state, the serous membranes and the parenchyma lose their sensibility; or at least it is diminished to such an extent, as no longer to occasion a degree of pain sufficient to compel the intellect to occupy itself with melancholy thoughts.

When sadness is the consequence of these chronic inflammations, it still depends on the brain, or rather on the intellect; that is to say, on the fear they inspire in the patient, which is the effect of his sensibility, and of the cultivation of his mind; but if we succeed in encouraging him, his melancholy will subside; whereas it is not in our power to make it cease, by the same means, when it depends on a well marked gastritis, or on an acute phlogosis of the parenchyma, and of the serous membranes. This may be further proved by the fact, that if you stimulate gently, by means of good wine,

the healthy stomach of an individual labouring under chronic inflammation of the serous or parenchymatous structures, his sadness will subside; whereas the same means will only aggravate it, if it be kept up by an acute or even chronic gastritis. To this it may be objected, that wine and good aliments nevertheless enliven individuals labouring under this complaint, but I would reply, that these substances only produce this effect when the greater portion of the stomach is not implicated in the disease, and when the disordered part is neither very extensive nor painful; that is to say, when they do not yet exasperate the gastritis: but if we continue to excite the mucous surface of the stomach, its partial inflammation will extend, and become general, and the wine will then serve no other purpose than that of adding to the sum of melancholy thoughts.*

I have been induced, from another motive, to cite gastritis as the principal physical support of sadness,—namely, because, when this passion is excited by a moral cause, all the viscera being healthy, it finally gives rise to gastritis, generally in the chronic form; whereas, it occasions the other phlegmasiæ only, when it is carried to that degree of intensity which resembles all the violent perturbations of the economy, and which may give rise to all kinds of diseases.

In respect to external inflammations, they have not the privilege, unless as general causes of grief, of exciting a state of sadness; and even then they produce it only in certain individuals; while gastritis gives rise to it indiscriminately in all, whatever be their character, their fortune, and the moral circumstances in the midst of which they may be placed. It must be confessed, however, that all inflammations, being susceptible of a repetition in the stomach, may become organic causes of sadness; but in these cases they only

* A most important truth this, which can never be sufficiently inculcated on the minds of physicians, and through them on every member of the community. How many mournful examples have we not, of utter depravity in persons labouring under the stimulation of alcoholic, vinous, or opiate potations, who sought to find in them a solace from cares; but who, on the contrary, were plunged into darker gloom, and impelled to raise their hands to suicide and murder. Ignorance of pathology, always mischievous, has led to the most pernicious consequences in the treatment of depression of spirits and melancholy. The associated irritations of the brain and gastric surface, which might have been removed by simple diet and a moderate exercise, (in the way of revulsion,) of the other senses, and of the respiratory and locomotive apparatus, as by change of scene, pure air, riding or walking, are converted into incurable hypochondriasis, or monomania, by the prodigal use of stimuli, tonics, and the like.—Trans.

produce it indirectly;—which affords us a further proof of the influence of the stomach over the nature of our ideas.

All these examples were required for the elucidation of our proofs of the necessity of the concurrent action of the viscera and brain, in the production and maintenance of sadness. They are not therefore, foreign to our purpose, and still less misplaced anticipations on the pathology of the passions.

The visceral pains which concur in keeping up sadness, tend likewise to produce dejection of spirits, discouragement, and even despair; they consequently diminish the intensity of the phenomena which manifest the state of life. But the power that watches over the preservation of all it has created, has known how to derive the remedy from the excess of the evil; for no sooner does the pain of grief occur, than, in a great number of individuals, another is developed in the same viscera, through the influence of thought, and reacts upon the brain in a manner very different from, and indeed absolutely opposed in its results to the former; since, instead of occasioning diminution of strength, and producing immobility, it is seen to develope a more or less impetuous re-action. No sooner does this occur, than the individual who suffered, obeying the voice of instinct, is agitated, with the view either of repelling the cause of the painful sensation he experiences, or of escaping from it. In the first case, he is affected with anger—in the second, with fear. These two affective movements exercise, therefore, an influence on the brain, capable of forcing it to react powerfully upon the nervous apparatus of relation. This doubtless is their most ordinary effect, when they have not attained their greatest possible degree of intensity; for when this occurs, we once more observe immobility, but attended with very different modifications of the organization. All this deserves to be explained. I shall commence by offering some observations on anger.

Anger, when occasioned by a moral cause, originates always in the intellect; but the idea which produces it succeeds only by exciting an acute pain in the epigastrium. It is the perception of this insupportable sensation, that with the rapidity of lightning, carries away our consciousness, seduces our intellect, and forces us to obey the impulse of instinct. Then are manifested the most impetuous and irregular movements,—first in the viscera, and subsequently in the apparatus of relation. When this passion has attained its utmost intensity, the blood is precipitated with violence to the ence-

phalon and other viscera;—the face becomes pale, the skin cold, and the muscles are agitated with convulsive movements. But the vital power soon reacts;—the face becomes flushed and tumefied,—the eyes are injected and sparkling,—the skin reddens,—the pulse which was before contracted and convulsive, becomes full, active, and accelerated; the whole external surface of the body assumes a higher temperature and colour; the muscles swell, and acquire a tenfold degree of strength;—the passion vents itself in vociferation, gesticulation, and rapid muscular movements;—the individual threatens, throws himself into violent agitation, and from the loss of his reason becomes liable to commit acts of the most atrocious nature, and the most injurious to social order. He resembles the most ferocious animal—he is deranged,—he is mad,—*ira furor brevis.*

Anger may depend on a physical cause; under these circumstances, it is the state of organic irritation, and even of inflammation of the sub-diaphragmatic viscera, which produce it, by giving rise to that sensation of uneasiness, which, in anger from a moral cause, is the result of thought. In all such cases, however, we should pay attention to the reciprocity of action; for it always happens that the inflammation excites in the brain melancholy thoughts, which, in their turn, reacting on the nervous apparatus of the epigastrium, produce in one individual anger, in another despair, &c. according to their disposition and to the series of ideas by which their attention was usually engrossed.

Abundant proofs of what I have just advanced, may be found in those acute diseases, which, owing to an ignorance of physiological principles, were denominated *malignant fever.* The greater number,* indeed, of these fevers, are cases of gastro-enteritis occurring in nervous subjects, with predominance of irritation in the superior portion of the digestive canal. The patient experiences hallucinations,—he sees objects which irritate, frighten, or gladden him. If, under these circumstances, we calm the gastric irritation by means of a local bleeding, before the brain has had time to become altered, these images will disappear, and together with them the movements

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* I have said the greater number, because those who maintain, that in all cases of delirium and convulsive movements there is arachnitis, labour under a great error. Numerous proofs of this may be found in the *Annales.* Besides, these cases of arachnitis are themselves in general nothing more than the sympathetic irritation of the brain, carried to the degree of suppurative inflammation, &c.

of anger, &c. which were their effect. If, on the contrary, we reproduce this irritation, by means of stimulating drinks, they will return. In cases of poisoning with certain narcotics introduced into the stomach, such as alcohol, opium, &c. we notice similar results. The first effects are hallucinations; or in other words, the patient sees or hears imaginary objects or sounds, at the same time that he experiences an internal sensation of pleasure or pain, whence results sadness or cheerfulness, and in a higher degree, anger and fury capable of leading to the most atrocious conduct. It is well known, that several of the oriental nations, when under the excitement of opium, rush like maniacs on the swords of their enemies, and there perish; or abandon themselves, after their victory, to the most ferocious acts,—the natural effects of the anger and factitious excitement produced with the view of inspiring themselves with courage. It is in vain to say, that these poisons act upon the encephalon; for the modification of the internal gastric sense precedes, and always produces, that of the brain. Apply alcohol to any other internal surface than the mucous membrane, it will inflame it, and, if absorbed, will even produce intoxication; but it will never give rise, unless the stomach has become secondarily inflamed, to that irascibility which invariably accompanies gastric irritations.*

The precipitate movements to which men abandon themselves, generally dissipate the paroxysm of anger; and if the cause that produced it be not very powerful, calm is re-established. If the reverse, however, is the case, and if the motive for anger is of a serious nature, either by itself, or through the power imparted to it by the irritation of an organ, it is constantly recalled to memory—the imagination exaggerates it, and the centre of perception acting incessantly upon the viscera, the individual feels, in the sub-diaphragmatic region, impetuous movements, which appear to be directed towards the locomotive apparatus, as if with a view of calling it into action; or rather the *perception* of these organic movements, which constitute real pain, tend to reproduce the agitation of the paroxysm;—anger is then chronic. Very often man resists to a certain degree, and his anger may be in part concentrated, and in part ex-

* Medical wranglers will affect to smile, and allege, that every man who is angry is not affected with gastritis. We know this; but we also know that individuals are often long thought to enjoy good health, whilst suffering habitually from gastric inflammation: and that even under these circumstances they may become extraordinarily fat.

haled; but, with a little attention, it will be constantly found, that the sensations he experiences tend to seduce *self* and lead it to determine the contraction of the fists, and of the masticatory muscles, as well as the immobility of the chest, which is interrupted from time to time by convulsive sighs, excited by the want of respiration. In such cases, man, although alone, seems to prepare for combat, and to place himself in the attitude for attack or defence. In this state, the heart propels the blood with violence to the viscera;—the vital erection of the brain retains it in the cranial cavity, where it produces pain, especially in the frontal region, and at the vertex;—the spasm of the inspiratory muscles accumulates it in the lungs and large vessels;—the epigastric pain attracts it in abundance to the mucous membrane of the stomach, and to the liver; whilst the cerebral influence precipitates the action in the nervous apparatus of the viscera, and of the locomotive organs. We shall examine, at a later period, the pathological effects of this frightful perturbation.

If the anger is more concentrated, it is because the percipient centre refuses to radiate stimulation on the locomotive apparatus: in such cases the viscera alone suffer, and always by the accumulation of blood contained in their tissues, arising from the circumstance, that the muscles do not tend to attract it towards them, and thus to produce a revulsion. Nevertheless, there is here a certain degree of compensation; for the immobility of the chest not occurring, the blood does not experience so great an obstacle in traversing the heart and lungs. From all this we may conclude, that in anger, the more powerfully muscular action is developed, the less permanent will be the engorgement of the viscera.

When the primary cause of anger is of a physical nature,—when, for instance, it depends on gastric inflammation, its mechanism is still the same; because visceral irritations, as we have already seen, can give rise to anger in no other way, than by occasioning hallucinations; that is to say, by creating, for the intellect, motives of fury, which, though imaginary, do not act less than if real, upon the organs. Such, for example, is the case with those who think they behold an enemy who threatens, or imagine they hear a voice that provokes them.

It may, perhaps, be asked, in what manner the hallucinations which give rise to the movements of anger, can take place. In answer, I say,—in the same way as every other possible hallucina-

tion; and as I think myself as much justified in treating of this physiological subject in reference to the present passion, as to any other, I shall offer a few observations upon it now.

And first, I must repeat the principle already laid down, that, for the physiologist, every idea is the effect of an organic irritation. A sensitive part of the body is stimulated by a foreign agent;—the cerebral centre perceives this stimulation, or rather experiences another, which is the consequence of it. Hence an idea: consciousness refers the sensation to the foreign agent of which it is apprised, and judges that the sensation depends upon the agent. Let us now imagine, although this foreign body be absent,—let us imagine, I say, in the part previously stimulated by it, an irritation similar to that produced by the agent, and we shall have *hallucinations;* in other words, the centre of perception, accustomed to associate the image of the foreign agent with the stimulation, continues to produce this association when it receives the perception of the latter, notwithstanding the absence of the agent which usually produced it. Now, examples of stimulations analogous to those produced by foreign bodies, are among the most numerous facts observed in physiology or pathology. Dreams are nothing else; and somnambulism offers the very highest degree of such stimulation.

It may, perhaps, be answered, that these errors only take place owing to the absence of reason; but what does this mean, unless that the brain is in a different condition from that of wakefulness? This does not prove that hallucinations can occur only during sleep; as the delirium of acute inflammation shows sufficiently well, that individuals may see imaginary objects although wide awake, and answer correctly to a number of questions foreign to the chimera which engrosses their attention. All that is proved on this subject is, that hallucinations are of rarer occurrence in the waking state than during sleep.

It may, moreover, be objected, that the hallucinations of individuals who are awake depend on a pathological state of the brain. This I am ready to admit; but I maintain, that this state *may* be the pure and simple effect of the irritation of another organ. Such influence is satisfactorily shown in those cases of delirium already cited, which disappear as soon as the inflammation of the organ that disturbed the brain subsides. With regard to chronic irritations, the hallucinations by which they are attended are developed slowly,

—the organ becomes diseased,—it acts upon the brain, at first, by predisposing it to those hallucinations, and next by compelling it to experience them. Thus, it is not in their first degree of irritation, that the organs chronically inflamed cause errors of thought; but when they have long tormented the centre of perception by their too active influence. Hypochondriacs, and those affected with hysteria, furnish us daily with proofs of the truth of this assertion; and insanity, which often manifests itself by a series of hallucinations, is frequently preceded by long-continued irritations in the digestive and generative organs.

It is impossible to experience hallucinations but in reference to external objects, the stimulations of which have been felt; this is a natural result of what has just been said. A hypochondriacal patient supposes himself to have taste of sugar, salt, or earth, because he has felt the impression resulting from the presence of these substances on the sense of taste; he never complains of a sensation which he has not before experienced. His stomach is diseased;—it irritates the brain, and among the irritations made sensible in this organ, there are some analogous to those occasioned by external bodies; this is the whole mystery. When a maniac sees devils in his delirium, it proves, that he has seen the representation of them in some painting, or that they have been described to him with the form of some animal familiar to him, and the shape of which has been joined to that peculiar to man. It is true that the imagination may create forms, which to some inattentive persons may seem new; but every sensible individual will readily discover in them objects more or less familiar to the patient. It will be unnecessary to present here further illustrations on this point; but it is still certain that the irritation of the brain is the cause of these errors.

Are there purely cerebral hallucinations? There may exist some, the cause of which has begun to act by irritating the encephalon; but in truth, these are of rare occurrence; for, with the exception of traumatic lesions, the encephalon never experiences irritations without instantly transmitting them to all the other viscera; and in the traumatic cases, where the irritation commences in its proper tissue, it cannot advance far, without an affection of the internal senses of the digestive apparatus, and of their nerves, supervening. In vain shall I be accused of prepossession on this subject; I maintain, and will continue to do so, for I am supported by facts, that all impressions,—even those produced

by moral causes, are transmitted, to borrow the language of Bichat, throughout the whole extent of the nervous apparatus of the two lives. This principle I believe I have shown to be well founded: if it be not, I can conceive of nothing in physiology that is so; but time will clear up this question for those who still remain in a state of uncertainty.

One of the most remarkable among the numerous hallucinations to which we are exposed, is that experienced by individuals, who, although deprived of a limb, are subject to pain which they cannot help referring to it. This fact is not more astonishing, however, than those of which we have already spoken. It shows, that among the stimulations transmitted to the sensitive centre, there are some analogous to those which were before produced by the irritation of the part that no longer exists. These stimulations may arise from an affection of the viscera, as well as from those of the nervous expansions corresponding to the cerebral and spinal nerves which are distributed to the skin and locomotive apparatus. They might even be regarded in certain cases as the effects of a too faithful and active memory; but all this has nothing to do with the main question before us.

Several of the passions belonging to the preceding series, increase the violence of anger; it is thus that sexual love, when it meets with obstacles to its enjoyment, gives rise to violent paroxysms of anger. The same takes place in respect to self-love, by whatever name it may be designated; in a word, whenever we are opposed in our enjoyments, we are more or less irritated against the obstacle; but when the fit of anger resulting from this is feeble and transient, we content ourselves with designating it by the name of *impatience*. I now proceed to examine the other passions founded on pain.

I have said that the re-action which resists grief and pain in general, is manifested under two general forms—one of which tends to repel, and the other to avoid the cause of this kind of pain. The first having been examined under the name of anger, I now turn to the second, which is fear.

Fear, like anger, is founded on a painful sensation which is sometimes developed within us through the influence of instinct, when we experience pain. This passion always supposes, in the animal experiencing it, the exercise of the intellectual faculties, whatever these may be; but the organic sensations and movements by which it is manifested, take place in the viscera, and sometimes in the whole

nervous apparatus. The different shades of fear are very numerous; we first notice the sudden contraction of the diaphragm, which produces an involuntary inspiration; but the expiration is incomplete —from which result a convulsive respiration and suffocation. If fear increases, palpitations ensue—the blood is retained in the heart and lungs—the skin becomes pale, contracted, and covered with asperities—the hair which traverses it stands on end—cold is felt at first over the whole surface, producing a chill, and occasionally it penetrates so deeply as to affect the muscles and cause a trembling.

This passion shows itself in the countenance in a particular manner—many of the secretions are altered—cold sweat sometimes supervenes—tears are shed in this passion as in grief, of which in fact it constitutes a variety. The urine and excrements are sometimes discharged with violence from their reservoirs—not, as has been said, owing to the relaxation of the sphincters, but rather from the sudden and convulsive contraction of the bladder, rectum, and even of the colon. In fact, these contractions correspond with those of the diaphragm, and even of the abdominal muscles; for fear offers this peculiarity, that it determines the convulsive contraction of the visceral and cephalo-spinal muscles, at the same time that it repels the blood from the exterior, and accumulates it in the viscera. This involuntary contraction of all the muscles, and the trembling of those of locomotion, indicate that the centre of volition is swayed by instinct—that the will does not react, and that the cause of fear continues to operate. If the centre of perception be too intensely occupied by it, and if the will cannot execute its purposes, all locomotive movement becomes impossible, and the animal remains in a state of immobility. When fear continues in an intense degree, the repeated contraction of the muscular coats of the hollow organs, prevents matters from accumulating in these;—the desire of making water is necessarily renewed—the stomach can no longer be dilated by aliments, and the individual experiences in the epigastric region a sensation of permanent constriction. The too long-continued contraction of the heart arrests the progress of blood to the brain—the individual falls into a state of syncope, and may even lose his life; but if the influx of blood to the brain, lungs, and muscles, be simply diminished, there results only weakness, paleness, a universal coldness, and the convulsive shivering of which I have already spoken.

Such is fear, so long as it is only a depressing passion: we rea-

dily perceive, that it must be referred to grief in general or to moral pain, of which it constitutes, however, a peculiar shade. It is also confounded, in certain subjects, with the first degree of violent anger; for it often happens, that in imminent peril, fear is first experienced; but self-love soon awakens anger, which gradually warms all the parts of the body that terror had already chilled.

There is another mode of resisting the depressing action of fear; —it is manifested by flight. This supposes a very considerable energy of muscular action; consequently, it can only take place in those cases in which fear has not attained that high degree of intensity, very generally designated by the name of *terror*, and which, as we have seen, may produce immobility,* and even death. As soon as flight commences, fear ceases to be simple—hope, which is a sentiment founded on pleasure, begins to shine upon the affrighted individual: it alternates with the fear, is mingled, and confounded with it, even to a degree difficult to determine: and fear becomes a mixed passion.

If, therefore, we combine, in different degrees, pain and pleasure, and cause to mingle with the first, sometimes the reaction produced by anger, at others the internal movements which tend to induce flight, we discover a considerable number of mixed passions, which it would be curious to examine, in order to refer each to the organic modification peculiar to it; since this is the principal point of view in which the question may be regarded as interesting to the physiological physician.

Let us glance over the passions, or rather the shades of passions, which, as being the result of the faculty we possess of observing all that surrounds us, and of comparing ourselves with the various objects of nature, and particularly with other men, are peculiar to our species.

Love and hatred necessarily constitute the basis of all our passions. Pleasure is associated with love, and pain with hatred.—Pleasure, which is the same as joy,† produces transports that are

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* This immobility, which is attended with a fixed attention towards the enemy, and which delivers up to him his victim by a sort of spontaneous movement, has been denominated in animals *fascination*. Vid. supra, p. 112—13.

† It might be objected, that some pleasures are attended with remorse, and consequently not with joy. To this I answer, that in such cases there is an alternation of joy and sadness; for I cannot conceive of the simultaneous existence of two opposite sensations. In these instances I perceive an habitual state of melancholy, interrupted,

manifested by acceleration of the circulation,—redness of the skin, vital erection of the whole periphery,—aptitude to muscular movements,—and momentary forgetfulness of certain wants, particularly of those of nutrition. If, under these circumstances, an individual be afflicted with a melancholy idea, giving rise to a movement of hatred,—if the reaction of anger be developed, all the agitation of pleasure instantly turns to the advantage of this passion, and anger soon acquires an extraordinary degree of energy. It is in this way, that the pleasure resulting from an advantageous comparison of ourselves with another individual, during the transports of self-love, which we denominate pride, is transformed, so soon as we are made to feel our inferiority, into a state of fury:—hence this passion is the most violent of all those to which man is exposed. It is for this reason, that we daily hear it remarked, that self-love when wounded is terrible in its vengeance, and hardly ever forgives. This kind of fury is attended with the most painful sensations, referred to the epigastric region, and reflected to the heart and lungs; as well as with an afflux of blood to the brain, so violent that the engorgement of this organ often abolishes for some time, or even for ever, the functions of the apparatus of external relation,—without speaking of the congestions sometimes permanent which may take place in other viscera.

If anger succeed in gratifying itself by vengeance, the individual experiences a horrid pleasure, which though reprobated by reason is not the less real, and the perception of which always occurs in the viscera: it may be referred to the enjoyments of gratified self-love. Nevertheless, it belongs to its nature to be soon followed by pain, which in its turn may give rise to a secondary anger,—such as the transports of despair, which may occasion all the organic derangement produced by the other kinds of anger, may cause flight, or be changed into melancholy. This new modification produces a depressing effect, by concentrating the vital action in the viscera, at the same time that it prevents their re-action on the expansions of the locomotive and sensitive apparatus.

I have cited the pleasure derived from the gratification of self-

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from time to time, by the joy of pleasure,—and surely this does not invalidate the correctness of my proposition. It may, moreover, be said, that in pain there does not always exist hatred. I shall answer this objection when I point out the different objects of hatred.

love as the most keen, in order to serve as an example of the organic modifications occasioned by pleasure, and by the pain which interrupts it. I would even go further, and assert, that it is the only pleasure capable of exciting violent transports. What are, indeed, the ideas that afford us pleasures capable of throwing us into a rapturous ecstacy? Are they those of glory? Whatever may be the subjects of this sentiment, (and we know that they are numerous,) it has its foundation in self-love. Are they the transports occasioned by a favour received? I do not perceive any other basis for them than this passion, which in the present case arises either from the idea of the preference granted to us over our rivals, or from the enjoyments we expect to derive from the means just procured for us. These enjoyments always enter within the domain of gratified self-love,—at least as regards the moral part of them, under which point of view I am now considering the passions. Is the pleasure adduced which we feel after the performance of a charitable act? However noble this kind of pleasure may be, its sole element is the enjoyment of comparison. I have elsewhere said, that benevolence might have for its motive the hope of gratitude, or of remuneration; but on close examination, we discover in this motive, enjoyments appertaining to comparison. Will the pleasures and joys procured by friendship, paternal and filial love, be cited against the correctness of my position? I answer, that, in all that is not instinctive, these pleasures must be allied to those resulting from comparison. Will my opponents allude to the transports experienced when we escape from an imminent peril? If we except all that is referrible to instinct, there remains, in those instances in which we owe our safety to others, gratitude, in which self-love plays a conspicuous part; and in those instances in which we think we owe all to ourselves, sensations which, as respect their moral part, are always referrible to those enjoyments derived from a comparison with our like. Perhaps the transports of love may be cited as exempt from the enjoyments of comparison. Doubtless they are independent of them in an instinctive point of view; but what is love when reduced to this condition? If you wish to make of it a passion in which moral considerations enter,—or in other words, a true passion, such as it must be in order to reign imperiously over our intellect, you will not succeed without introducing into it enjoyments of comparison. Now, whenever the transports of love are deranged by an obstacle, whatever it may be, self-love,

pride, and vanity, are excited with the greatest energy, and point out the moral and true element of this all-powerful passion.

It may be said, that animals which have no moral feeling, are, nevertheless susceptible of the most terrible paroxysms of anger, when disturbed in their venereal pleasures. This doubtless is true; but it is only the instinctive part of the passion; or rather it is not the passion, but an affective movement devoid of any moral element. The proof is, that the instinctive movement disappears with the want; whereas, in our species, the passion, nourished by thought, continues, although this basis no longer exists; and I maintain, that the nourishment it receives from thought is derived from comparison. Whoever will examine attentively what occurs within himself, will find no difficulty in discovering the proofs of the correctness of my assertion.

There are other passions very exalted in their enjoyments, and very terrible when they encounter obstacles. Such as *fanaticism*, whatever may be its motive. This is probably the most moral of all the passions; and yet it is the one in which the enjoyments of pride, vanity, in a word, of self-love, play the most conspicuous part. Is it then astonishing, that anger and hatred should be displayed with so much violence and tenacity against whatever is capable of troubling the sublime enjoyments of enthusiasts of all sorts? Hence, no passion has caused the flow of so much blood as fanaticism, which might be defined the *pre-eminent abuse of the intellectual faculties*. It is the most formidable scourge of the human species, and one which, in some measure, avenges animals for all the advantages which our species possesses over them. I shall not speak of the pleasures of honour, as it is too evident that they are founded on the comparisons of self-love.

I now proceed to point out certain organic modifications, to which I have not yet alluded, and which correspond to some of the passions, or of the affective movements, I have just enumerated.

In *horror*, which must be referred to fear, of which it constitutes a very peculiar modification, we experience a sensation of coldness, extending over the whole surface of the skin, and the hair stands on end in a very astonishing manner. In some instances this organic movement appears simple, as, for example, when we discover something hideous that displeases us, without, however, occasioning a strong feeling of terror. But the reluctance we experience in approaching such an object, points out sufficiently, that

it is mixed with a feeling of fear. In other instances, to these symptoms are added a chill, a sense of suffocation, and palpitations of the heart;—under these circumstances fear exists, such as we have described it. The sight of certain objects,—the hearing of certain sounds, give rise to involuntary tremblings, and to convulsions. I once knew a Prussian officer who could not see an old woman, a cat, or a thimble, without experiencing convulsive agitations, and without jumping and screaming. We know that the rubbing of two dry bodies,—the sounds of a file, or of the harmonica harass to a most distressing degree the nervous system of many delicate individuals, and derange the harmony of the principal functions. Almost every nervous subject has an object of horror or disgust. All these effects must be referred to instinct; for passion assuredly has nothing to do with them.

The same remarks are applicable to the vomiting which some sensitive individuals experience at the instant they are told they have eaten something for which they have a disgust. With some of the most irritable among them, it is sufficient to imagine, that the object for which they entertain disgust is in their mouth or stomach, in order that this latter viscus should contract with violence, and eject even blood. Although instinct acts in all these instances, it is, nevertheless, certain that the cultivation of the intellect contributes greatly to produce the exalted susceptibility of the viscera, by imparting to the brain a degree of influence over the internal organs which it would not possess in a purely natural state.—But it is very evident, that the pleasures and pains of comparison have no part either in the action of the encephalon, or in the derangement it occasions in the functions.

The same is not the case in *shame*. This affective movement is one of the numerous modifications of wounded self-love; and nothing is more evident than the influence it exercises on the organic tissues. It acts particularly on the head, to which blood flows with violence; and as, in this case, the epigastrium does not experience that kind of constriction which withdraws the blood from the surface of the body, and is so often superadded to cerebral irritations, this fluid is accumulated in an extraordinary manner in the capillaries of the face;—the eyes participate in the suffusion, and sometimes to such a degree, that vision becomes deranged. The ideas are confused,—the muscles are no longer at the disposal of the will; and in the last stage of this singular feeling, the individual affected

with it, can neither think, speak, nor move with regularity. Shame, which sometimes assumes the name of *bashfulness* is usually met with in young and timid subjects. It generally ceases with the progress of age, and by habits of social relations; but in some instances it is very difficult to overcome.

Compassion, in which we may discern the influence of the instinct of self-preservation, and, in innumerable cases, a mixture or alternation of the pleasures and pains resulting from a comparison of ourselves with our fellow men, exerts a well marked influence on our viscera. The internal movement by which this affection is nourished, is principally felt in the epigastric region. The heart participates in it;—in the language of the world, it is *broken;* but we should recollect that the vulgar refer to this organ numerous sensations which depend on the stomach. Compassion tends to produce a visceral concentration without reaction: hence, it should be classed among the affective movements which produce a depressing or debilitating effect. This sensation being painful, the individual endeavours to discover the means of removing it. Some attain this end by succouring the unfortunate;—others by diverting their attention in seeking out motives calculated to diminish the interest inspired by the sufferer;—finally, others avoid its effects by flight. It is plainly perceivable that *benevolence* is not a necessary effect of compassion, but a simple organic movement. It depends solely on thought, and is consequently subordinate to the series of ideas which predominate in the individual, and which, in most instances, result from his education. Hence, benevolence is purely moral; it is a virtue; whereas compassion is primarily an instinctive movement, more or less increased by the pleasures or pains resulting from the comparison of one individual with his fellow creature. It is purely instinctive when applied to animals, the sufferings of which we witness;—when it has for its object the human species, it is, in most instances, mixed.

In persons endowed with a large share of sensibility, grief often produces a modification in the organic tissues, as evident in the interior as on the exterior of the body. I allude to the movements producing *tears.* We weep from various motives;—sometimes tears result from the regret we feel for the loss of a person beloved, —at other times they are occasioned by the distress and abandonment in which we are left by others. The sight of an unfortunate being,—the physical or moral picture of his misfortunes,—the idea

that we might have been the cause of these misfortunes,—the fear of torments, of death, of ignominy,—the humiliation of self-love when at the height of its enjoyments,—purely physical pain,—all these causes may excite the effusion of tears. We also weep for joy,—from the pleasure of seeing once more a beloved object,—from the softer emotions occasioned by a good action, a generous sentiment, an heroical devotedness, the sacrifice of self in favour of a fellow being, sometimes even to the advantage of a bitter enemy. In a word, weeping is not produced by any one particular kind of pain. It depends always, it is true, on a painful feeling, even in those cases in which the exciting cause is a motive for joy, since in such instances this joy alternates with and is counterbalanced by pain;—or else it is a pleasure, which, by its excess, is converted into pain. However this may be, tears resulting from a moral cause are always preceded and prepared by a series of movements and sensations, which it will be interesting to examine with attention.

We first experience a feeling of compression which originates deeply in the epigastric region, impedes the movements of the diaphragm, and thus causes a true dyspnœa. This kind of constriction, produced primarily by the influence of the brain, (since it results from the power of thought,) meets with resistance from instinct, which causes from time to time, and in a sudden and violent manner, the depression of the diaphragm and the elevation of the ribs;—this gives rise to convulsive inspirations, denominated *sobbings*. In the mean time, the constriction, following the course of the œsophagus, rises towards the pharynx; this constriction is not imaginary;—it is in fact so real, that deglutition becomes impracticable; and the derangement of the mucous secretions, producing dryness of the throat and even of the whole mouth, with thirst and a sensation of heat, attests sufficiently that the organic functions of the parts to which the sensation is referred are altered. the larynx also partakes in this spasmodic secretory affection,—it becomes somewhat constricted, and its mucous membrane, as well as that of the trachea, is dry and burning hot, causing the voice to become hoarse and interrupted with sobbings. These phenomena are sometimes carried to such an excess that the individual experiences acute pain, not only in the throat and pharynx, but also in the stomach, chest, and in all the inspiratory muscles,—without excepting those of the abdomen, which seem to him as if likely to be torn asunder. He imagines he feels a large and round body

rising towards the pharynx, and impeding respiration,—he screams, and sometimes is affected with general convulsions. Instinct has then no longer any control over the inspiratory muscles, and asphyxia may be produced, and even end in death. In other cases, danger becomes imminent from the congestion of blood in the brain.

These phenomena, however, very seldom attain such a degree of intensity; for in the greater number of instances, the constriction of the pharynx, and the stagnation of blood in the head, face, and globe of the eye, are relieved by an abundant secretion from the lachrymal glands. As soon as this flow is fairly established, a feeling of pleasure is mingled with the painful constriction of the pharynx, which it interrupts, and finally removes entirely.

In a great number of individuals, the flow of tears is much more easily excited,—as is exemplified in children, many of whom retain, through life, the same facility in shedding tears. In such individuals, grief has no sooner begun to produce the tracheo-pharyngeal constriction, than the lachrymal glands are called into action. Hence we remark, that in them grief is not as intense, durable, and dangerous, as in other individuals. There are, indeed, a few who possess the weeping faculty to such a degree, that the least pain, either physical or moral, occasions the flow of tears. These persons acquire by practice such a command over their lachrymal glands, as to increase at will the secretion of these organs, by figuring to themselves, as we notice in actors, griefs and pains they are far from really experiencing. However this may be, we cannot, in correct physiology, but regard the discharge of tears, when not the result of a morbid state, as a modification of pain produced by a moral cause.

Though the flow of tears is excited through the influence of the brain whilst in the exercise of thought, it is worthy of remark, that this organ can only occasion it by acting on the visceral nerves; and that it imparts, at the same time, to the inspiratory muscles, a direction the reverse of that which the visceral movements to which it has given rise, tend to impart to them. It might, indeed, be thought, that the viscera act on the muscles independently of the brain. We shall examine, in another place, this question, the solution of which constitutes one of the most delicate points of human physiology.

In pointing out the mixed passions, I have not, perhaps, suffi-

ciently enlarged on the effects produced on the system by the alternations of pleasure with pain, of love with hatred, of depression with anger, of fear and despair with hope. In these different conditions of *self*, I can discover only two things of any importance to the medical physiologist;—the sudden transition from pleasure to pain, and from pain to pleasure. Thus, when we pass from love to hatred, we only suffer after having enjoyed; and when hope succeeds to despair, it is still an alternation of pleasure and pain. Of this we may be readily convinced, if we reflect, that to hope is to enjoy, and consequently to love the sensation or the object which gives rise to it; and that to fear is to suffer actually from the anticipation of misfortune, and consequently to hate either the object that is to cause this misfortune, or the sensation which gives rise to the idea of it; since, in anticipated grief, as well as despair, we can discover nothing but a pain necessarily hated by the individual who experiences it.

I have already said, that both love and hatred are felt, in a violent manner, solely for our fellow men,—that these passions were not at all directed to inanimate objects, and only in a limited degree to animals. From this it results, that when our pains and pleasures depend on these latter causes, it is principally the sensation that we hate, and very rarely the object producing it. There are, likewise, a number of cases, in which we have only as motives for our love or hatred, objects of the latter kind. Such are, for example, our diseases;—for then our love or hatred has commonly for its objects, our own sensations; unless, indeed, owing to mental aberration, we direct it towards our acquaintances; but as these passions, in such cases, do not arise from a moral cause, they only continue as long as the disease which produces them. In a word, I regard it as sufficiently well proved, that we may love pleasure and hate pain, although our love or hatred be not directed towards any other objects than ourselves.

If we now examine what takes place in our organs, when pain suddenly succeeds pleasure, we discover, that the state of universal nervous irradiation, and of vascular expansion, which promotes every movement, sensation, partial circulation, and secretion, is suddenly replaced by an opposite condition of the system. Indeed, sensibility becomes concentrated, together with the circulating fluids, in the viscera,—the rest of the living machine falls into a state of torpor, which is only interrupted, from time to time, and in a con-

vulsive manner, by the irregular irradiations from the suffering viscera; and reciprocally, whenever pleasure is developed with sudden energy, in an individual in whose viscera pain has concentrated the nervous influence and the fluids, the expansion, towards the rest of the organs, takes place with so much rapidity, that these latter, and the viscera themselves, experience very violent commotions. Hence, 1. In pain there is concentration of action, sensibility, and fluids, in the viscera, with partial and impetuous irradiations to the other tissues. 2. In pleasure there is a universal expansion of action, sensibility, and fluids, through all the tissues,—without excepting the viscera themselves. Such are the principal phenomena resulting from the alternations we are examining. It is proper, moreover, to bear in mind the expansion occasioned by anger, which sometimes attains a much greater height than that produced by pleasure; but in such cases, a certain degree of enjoyment is combined with the painful condition of anger; it is produced, in my opinion by the desire of revenge, which cannot be any thing else than a pleasure by anticipation. I compare this pleasure to the one accompanying the transports of despair, which result only from a mixture of anger; and it is proved, at least in my opinion, that pain always produces a concentration, and that the reaction resulting from it arises constantly from pleasure, when it becomes sufficiently powerful to produce a general expansion. We shall soon examine the pathological consequences of these contrary alternations; when they succeed each other rapidly and frequently their effects are terrible.

CHAPTER VIII.

OF LAUGHTER, ENNUI, AND SLEEP.

Three physiological states belonging to the functions of relation, now present themselves for our examination—I allude to laughter, ennui, and sleep.

Section I.—*Of Laughter.*

Laughter, as has been said, is produced by contrasts. Whenever we perceive, through the medium of the two intellectual senses,—or, in other words, as soon as we see or hear something that forms a contrast with the subject which before occupied us, we burst into laughter, provided the new idea has nothing painful in it. The sensation we experience at the moment the contrast strikes us, is instantly felt in the epigastrium, and produces laughter. The rest consists, as has been proved by M. Roi, in his dissertation, of sudden and convulsive movements of expiration. This mechanism, therefore, depends on the abdominal muscles; and, as these are supplied with nerves from the great sympathetic, I believe, that, in a majority of instances, laughter is executed in consequence of a visceral influence. I simply mean, that the brain does not produce it, without acting on the whole nervous ganglionic apparatus, at the same time that it calls into play the expiratory muscles. When friction is applied to the latter, (the tickling of the sides,) the cause of laughter appears to act directly on the muscles which execute it; but as the stimulation of another part of the body, of the soles of the feet for example, is also sufficient to produce it, we ought to lay more stress on the cerebral sensation than on any other cause; thus, in the idea of a contrast, of a dissimilarity, in the tickling of the sides, and of the soles of the feet, in the irritation of the viscera from inflammation, &c. there is always a perception in the centre of relation, in consequence of which laughter is commanded and executed.

I shall not stop to detail the muscular movements by which the action of laughter is performed. It will be sufficient for my purpose, in order to show the danger of these kinds of convulsions, to direct attention to the contraction of the abdominal muscles; which, when intense and continual, offers an obstacle to the dilatation of the chest, and consequently to inspiration. As regards the contractions of the muscles of the face which draw outwardly the angles of the mouth, and enlarge this cavity, they depend upon the same sensation that produces the contraction of the abdominal muscles, and are not more astonishing than the movements of the other affections. But it appears to me, that laughter confirms what I have said of the affective movements and of the passions. It is, in fact, an affective movement; since it is attended with pleasure, when

moderate, and with pain when excessive; and, consequently, with love or hatred, either for the sensation or for the cause. Now I will ask, what would constitute laughter, if the sensation referred to the viscera, as well as the muscular movements which accompany it, did not exist? Could the brain laugh alone? Certainly not; any more than the other affections could exist, if the modifications of the viscera, which render them evident, did not take place. But I have not exhausted this subject, and will recur to it. Laughter precipitates nervous action in all the senses, and in all the muscles, —it accelerates the circulation, promotes perspiration, and, in general, every function, when it is not carried to that degree which interrupts the action of the heart and lungs, and accumulates blood in the brain.

The act of smiling has been with reason distinguished from laughter, properly so called. Contrasts, which are the ordinary causes of the latter, are not at all necessary for the former. Every cheerful affection or passion,—that is to say, when founded on pleasure,—can, if in a moderate degree, excite a smile; for, in their greatest intensity, these modifications of *self* assume a serious nature, as may be exemplified by love, the most cheerful of all the passions, but which, in its most violent transports, ceases to be joyous. At any rate, laughter has this in common with smiling, that like the latter, it implies an agreeable state of the mind. Hence, the cheerful passions predispose to laughter;—the one who smiles habitually, is disposed, whenever the occasion is presented, to burst out a laughing; while a melancholic individual is often unmoved by the most striking and unexpected contrasts. Every one knows, that cheerfulness may be feigned; and that, for the same reason, an individual may smile at will, and without any cause for joy.

Fits of laughter are likewise simulated, and we may, to a certain extent, create within ourselves the feeling proper to this affection. Laughter is susceptible of imitation; we laugh violently without any other cause than that of seeing others laugh,—which indicates another point of analogy between laughter and our passions. Whenever, in melancholic affections of the mind, a smile appears on the countenance, it is always, in my opinion, the result of an idea producing a pleasurable sensation; for we have seen, that in hatred, anger, and even in despair, similar sensations frequently supervene; —yet, as they are but transient, their true characteristics cannot be completely established. Hence, the smile of those who are in this

condition has something sinister, which distinguishes it from that produced by a continual state of joy and happiness.

Laughter is sometimes the result of disease;—and why should this not be the case, since all the affective movements may depend on a similar cause? This constitutes another point of analogy which deserves to be noticed. Hysterical women experience sensations of joy and grief,—cry and laugh violently without any moral cause, and from the mere effect of the irritation of the abdominal nerves re-acting on the brain, in spite of the will. But the other passions also frequently result from the same influence, and this is an additional reason for admitting the dependence of the brain relatively to the other viscera. In a word, these latter have the property of exciting in us a state of cheerfulness, of melancholy, or of fury; and the movements which such modifications of the mind produce in them, are sometimes excited by causes acting primarily on their tissues.

Section II.—*Of Ennui.*

This is a condition of our mind which merits the attention of physicians and ideologists. It depends upon that want which I have pointed out in a former part of this work, as one of the characteristics of man, viz. self-observation, and comparison of himself with all surrounding objects. Hence ennui is never found in animals. It is true we sometimes see them in a state of melancholy and languor, which might have received that name; but it would have been applied very improperly; or if we desire to retain it, we must of necessity admit, that this condition does not depend on the same cause as in the human subject. An animal languishes because it is deprived of the stimuli which its instinct requires; this state is produced by the defect of nourishment, or exercise, or of an habitual companion, of its female or male respectively, its young, &c. The same species of languor is also met with in man; but the latter is subject to another kind of sadness, which does not arise from such a cause, but merely from a deficient moral excitement; and it is this which constitutes true ennui.

In my opinion, ennui depends on deficient moral excitation in those who have contracted the habit of such excitations; for the savage and the countryman, whose education has been neglected, are not susceptible of this feeling. When their wants are gratified, they remain in a state of inaction, without any further desire;—

thus approximating to the brute creation. The same thing does not occur among those individuals who are accustomed to think a great deal ; for, as soon as the external causes of moral excitement cease to act, they begin to be weary. We must, however, establish a distinction between these individuals. They whose memory is strong and well stored, from having read, seen, and observed a great deal, find within themselves sufficient motives for occupation, because they exercise themselves in recalling to their minds past ideas, and in comparing them with those suggested by present objects. Hence, learned men, and those accustomed to observe and compare themselves with the various objects in nature, are but rarely tormented with ennui; whereas, individuals destitute of memory, or of a large share of reflecting faculties, and who are only accustomed to the moral enjoyments they derive from conversation, reading, and sports, are ever insufficient to their own satisfaction, and unable to resist ennui. It is in such persons, that this state of things becomes a real torment. Whatever, indeed, may be the extent of our moral means, if we are deprived of things which we passionately desire, we are exposed to suffer from ennui; because, the imagination being obstinately fixed on one object, we reject every idea that could divert our attention and preserve us from this distressing feeling.

Many people are subject to ennui when exposed to the conversation of fools, and even of those who continually direct their attention towards subjects that displease them, and to trivial ideas; or who express in an insipid and common manner, ideas already familiar to them, and which they have before examined in a more extended and interesting point of view. We are also wearied whenever any one compels us to fix our attention on questions of which we are ignorant, or wishes to make us conceive and retain rapidly, a number of things which would require to be examined successively in detail, and at some length. But in all these cases the principle is the same;—because we fail to receive a moral excitement proportioned to our faculties and our wants. In some instances, however, anger, which is awakened in us under these circumstances, creates a diversion which retards, during a longer or shorter space of time, the disagreeable sensation of ennui.

Whatever is the cause of ennui, it is announced by a painful sensation, referred to the epigastric region, in which is felt a kind of emptiness, a coldness, and a peculiar relaxation which seems to be

repeated in the locomotive apparatus. Gaping takes place, and is succeeded by stretchings, and universal uneasiness. Those who are disposed to sleep give way to it;—others become agitated, and cannot find a single position capable of relieving them from their torments.

If we now examine what takes place in the viscera, we shall discover, that the sensation of ennui is distinctly felt in their tissues. Thus, the pain in the stomach is evident, and produces the gapings; it is reflected to the whole splanchnic nervous apparatus,—it rivets the attention of *self*, suspends the power of thought, and diminishes the influence of the brain over the inspiratory muscles. The frequency of respiration is thus diminished, and blood is accumulated in the lungs and in the heart, which contracts less frequently. From this stagnation results the sighing, so generally noticed in such cases;—the nervous influence is also diminished in the muscles of the extremities, whence arises that sensation of uneasiness which induces us to agitate ourselves, and which I attribute to the thwarted want of locomotive movements.

We again discover here that reciprocity we have pointed out in several of the passions. Thus the privation of aliments and of nutritive substances in general, places the stomach in a condition analogous to that caused by ennui; and the brain perceiving this, ennui itself is soon manifested. But what points out, in a still more striking manner, the influence of the stomach over this feeling, is, that whatever be its cause, it is always removed, at least for some time, by the ingestion of aliments, and particularly of fermented liquors. Wine removes ennui and excites joy; *Adsit lætitiæ Bacchus dator*, said Virgil: but wine ceases to exercise that influence whenever the sensibility of the stomach is too powerfully excited; for, under such circumstances yawning and ennui may still occur, although stimulants are in excess in the stomach. Let us, therefore, express the fact, such as it offers itself to our observation, by saying, "the deficiency of moral excitement can only produce ennui by affecting in a painful manner the splanchnic nerves; that is to say, by placing them in a state of excitement which may also result from a deficiency of stimulating *ingesta*, as well as from their excess, and from a certain degree of irritation, the consequence of a pathological condition of the stomach; and whenever any cause has produced, in this viscus, a degree of excitement resembling that to which ennui can give rise, this latter feeling may really follow in a

secondary manner." We should carefully distinguish, therefore, the ennui produced by a moral cause, from that resulting from a physical one; since the first depends on the brain, and the second on the nervous apparatus of the viscera. But as, in conformity with what I have said above, the latter might be classed among the hallucinations, it would follow, that true ennui depends exclusively on moral causes.

When we endeavour to discover the mechanism of yawning, which may be regarded as the first sign and principal phenomenon of ennui, either moral or physical, we encounter many difficulties. It has been thought to be produced by the want of respiration, or to be destined to renew the air stagnated in the lungs, when respiration has been for some time diminished in frequency. But such suppositions are erroneous, and it is sufficient to have practised medicine to be convinced, that dyspnœa has never alone produced yawning. The movement is caused by a peculiar sensation originating, or rather manifesting itself, at the bottom of the throat, and at the superior part of the neck, under the influence of the same causes that produce ennui. We feel ascend along the trachea and œsophagus, and towards the fauces, a sort of constriction which instinctively impels us to open our mouth, and to inspire slowly, and expire with effort and noise, a large column of air. At the same time, we experience contractions in the diaphragm, and in the muscles of the jaw, os hyoides, pharynx, face, and neck; in the platysma myoides, and in all those exercising any agency in the act of respiration. The biceps brachialis, the pectoralis major, and some other muscles of the scapular region, partake, to a certain degree, of the irritation; since we often experience in them a sort of thrill. All these movements are attended with a degree of pleasure; insomuch, that yawning may be said to be an agreeable convulsion. But what is still more agreeable, is the inspiration, and especially the expiration of that large column of air which passes along the mouth and trachea,—dilates the bronchia,—distends the pulmonary vesicles, and penetrates so deeply in the pharynx, that a greater or less quantity always reaches the cavity of the stomach. A certain degree of languor, referred to the region of the diaphragm, always succeeds yawning; but when frequently repeated, we experience in the stomach itself a sensation of cold, relaxation, and even debility. And reciprocally, when this viscus has been cooled and relaxed by the passage of chyme from it into the intes-

tines, or by the ingestion of cold water, the want of yawning is manifested, and the repetition of this phenomenon seems to promote the evacuation of the contents of the stomach, and hasten the the return of appetite.

It appears to me, that the lungs are much less influenced than the stomach by the acts of yawning; in fact, when this convulsion is not the effect of a moral cause, (always analogous to that which produces ennui) and not excited by imitation, it is generally the result of an affection of the stomach, and of the surrounding plexus, and never of a pathological state of the lungs; unless, indeed, the latter produces it by a sympathetic action on the epigastric region, as sometimes happens after violent fits of coughing, which occasion a sensation of uneasiness in that part; but I have never remarked that pleurisies, pneumonias, and particularly aneurisms of the heart, which are the most effectual causes of the diminution of the volume of air contained in the lungs, give rise to yawning.

The next thing to be determined, is the final cause of yawning; in other words, the object which instinct proposes to attain by exciting it.

This appears to me to be a difficult question; for if the want of air does not constitute the principal object of this great inspiration, what purpose can it serve? Is it to obtain a deglutition of air, and by this means to relieve the uneasiness of the stomach? or does this require for its relief the sympathetic influence of an ample dilatation of the pulmonary tissue? I am aware that the gaping of animals placed in vacuo, and of newly-born infants, is brought forward in proof of the want of air for the lungs themselves. But against this opinion it may be alleged, that pneumonia and other pulmonary congestions, do not give rise to yawning. On another ground it may also be answered, that a deficiency in the stimulus of air, cannot fail to cause a sensation of uneasiness in the epigastric region, and that hunger may suffice, in the new-born infant, to carry the uneasiness to a degree capable of inducing yawning. I do not deny, that the want of air may concur in this process; but I believe, that it does so by producing a sensation of uneasiness in the epigastric region, which also is the most ordinary cause of this phenomenon; since it can, by itself, produce it; whereas, the want of respiration has not this effect, when the stomach is agreeably stimulated by *ingesta*, although the act of digestion invariably increases the quantity of blood circulating in the lungs, and, consequently,

adds to the intensity of the dyspnœa.* Experimentalists will, perhaps, one day solve these difficulties. I therefore commit them to their charge, in order to pass on to the examination of other subjects.

Section III.—*Of Sleep.*

Sleep is defined, by modern physiologists, to be the repose of those organs charged with the external relations. Accordingly it is manifested by a cessation of the functions of the senses,—of those of the muscles submitted to the will, and by the abolition of the intellectual and affective faculties. Sleep, to be complete, ought to unite all these conditions; but as it is susceptible of numerous shades, it must be described before a just idea of it can be formed.

Sleep is announced by diminished activity of the senses, diminished attention, aversion to voluntary movements, and a kind of languor, which is believed to be universal. We experience in the frontal region, and especially about the eyes, a sense of heaviness, and, as it were, of fulness; the conjunctiva becomes injected, the eyes appear tumefied, the upper eyelid falls, and, if we attempt to raise it again, feels as if weighed down. This congestion of the fore part of the brain, is often accompanied with yawning, and a feeling of fatigue in the limbs, which leads us to stretch them in different directions, causing what is called *pandiculations.* While we abandon ourselves to this feeling, we experience, in the muscles thus stretched, a kind of convulsive trembling. When we feel an inclination to sleep, we experience a peculiar sensation at the epigastrium, similar to that of ennui and gaping; it is a kind of languor which cannot well be defined. Instinct leads us to seek the most proper posture for repose. Respiration becomes slower, and, in some individuals, stertorous from the commencement; afterwards it is more calm; the sleeper no longer manifests any signs of sensibility to external impressions. His intellectual faculties appear to have ceased to exist, nor can we discover any voluntary

* Yawning is also manifested in the beginning of the paroxysms of intermittent fevers; and this is another reason, agreeably to my opinion, for referring its principal seat to the epigastric region; for it appears to me certain, that the uneasiness of this region, which calls the blood into the viscera and causes the coldness of the exterior, is likewise the exciting cause of this yawning. I shall, hereafter, prove that all irritations, suddenly developed in any part of the body whatsoever, can excite a chill, and that the cold stage of intermittent fever cannot be otherwise explained.

movement. In the first moment, or that of somnolency, the individual has some confused ideas; he still thinks, but judgment fails him; he speaks in an unintelligible manner, and, in fact, is delirious. He soon loses every idea, after having lost every movement, even those of the respiratory muscles; for although the centre of perception does not cease to feel the want of respiration, yet as this deficiency is less felt, the inspirations are few, and in proportion as they are retarded they become fuller;—this is what causes *stertor*. The sleep having lasted for some time, becomes less profound; the centre of perception feels, in addition to the want of respiration, the uneasiness which arises from a fatiguing posture, and the individual moves, then turns over, but without, on that account, awaking. His memory begins to resume its action: he combines the ideas it retraces with the confused impressions he receives from without, and also with the irritation of his internal senses: he dreams. Sleep becoming still less profound, the sleeper feels certain wants, such as those of making water and of coitus. He awakes for an instant to gratify the first, and sometimes the second rouses him from his rest by feigning the act of copulation. Finally, the disposition to receive external impressions is restored, in proportion as the want of sleep diminishes. Light penetrates through the eyelids, noise is heard, all the wants are felt; that of exercise is developed last;—when this occurs the waking state is complete, and very soon a desire for motion engages man to quit his place of repose.

If nothing counteracts the disposition to sleep, man abandons himself to it without feeling any thing; but if efforts are made to oppose it, he considers himself as deprived of a pleasure, and threatened with pain; for then he strongly feels that state of languor of which we have spoken; and, finding it agreeable, he becomes irritated against the causes which tend to rob him of it. Pain is also felt in the head, eyelids, eyes, &c. to the last of which light is insupportable.

Hence it is by pleasure that we are invited to abandon ourselves to sleep. This pleasure re-appears once more immediately on awaking too early, and it is so much the more keenly felt, as the period of sleep has been shorter. But if it has continued all the time necessary for the gratification of the want, external impressions, far from being painful, are agreeable, and the state of sleep is not regretted.

If we judge of it by the appearance of the sleeper, the principal phenomena which characterize the state of life are considerably diminished during sleep. Yet many physiologists pretend, that if the external functions are diminished, the internal acquire a new degree of energy. According to them, heat is concentrated in the viscera, and nutrition becomes predominant.

I cannot admit the correctness of this opinion; since the want of action in the senses, muscles, and intellect, must necessarily give rise to a diminution of energy in the internal functions; for it is proved that the action of an organ is reflected to the others by means of nerves,—thus giving rise to sympathies; and every one knows, that this mutual communication of sensations between the various organs, is one of the principal causes of the maintenance of life. Facts prove my assertion; for during sleep circulation, and consequently respiration, are diminished; perspiration is less active, and digestion is effected in a much longer time than during the waking state. The difference in the last respect is so great, that appetite returns many hours before the usual time, in those persons who abandon themselves to unaccustomed watchings, and they require one meal more than customary. Hence the common proverb, he, who sleeps, dines. The secretions, such as those of mucus, urine, saliva, and bile, are also less abundant. Where then can we find this pretended increase of the internal functions? To solve this question, let us examine the facts upon which its supporters have founded it.

I. *The pulse*, they say, *is fuller than during the waking state.* If this be so, it is because the heart beats slower, and because the external part of the body, being protected by thicker coverings, is warmer and more penetrated by blood than it was before. But cover the skin of a person who is awake as much as of one who sleeps, his pulse will be quite as full, and more frequent; hence circulation will be more *accelerated.* One of the reasons which give support to this proposition is, that we often abandon ourselves to sleep, with a stomach filled with stimulating ingesta. In these cases the acceleration of the course of the blood depends on the irritation of the gastric apparatus,—an irritation, which having no revulsion, either by the action of the muscular system, or of the intellect, or senses, must necessarily be reflected to the heart and skin. Now if you observe one who sleeps with an empty stomach, you will never remark this pretended acceleration, unless it be oc-

casioned by dreams; but we have already said, and will prove very soon, that dreams belong only to incomplete sleep.

II. *The temperature of the skin is increased.* This increase is purely factitious and accidental; it depends on the coverings, and on immobility, two causes that retain caloric in the cutaneous tissue; it may also proceed from too copious a meal, the influences of which are united to those of the preceding causes. But cover the man who sleeps, less than when he is awake; his skin will cool faster, and the external cold will produce an internal inflammation sooner than if he were awake. Besides, if it be certain that circulation is retarded in sleep, it is utterly impossible that the heat of the skin should be greater.

III. *Persons who abandon themselves a great deal to sleep, are more fleshy than those who sleep little.* From this it is inferred, that nutrition is more active in the former than in the latter. —This conclusion is erroneous. Thus we have seen above, that digestion is performed slower in the sleeping than in the waking state. How then could it happen, that nutrition should be in inverse ratio to the digestive assimilation? The absorption of the chyle is retarded, as is proved by the state of fulness of the abdomen which we experience after awaking, and by the urine we discharge several times before the abdomen is lessened in bulk, and appetite is felt. Are these, then, signs which announce that nutrition has been increased during the sleep which has just terminated? Young subjects only awake with an appetite. All adults, and more particularly persons advanced in age, are obliged to wait some hours for their appetite, before they can breakfast; whereas, if they have passed the night awake, they feel much sooner the want of food. It is then very certain, that sleep retards digestion. But we are again told, that sleep fattens. Admitting this to be the case, it is an additional proof in favour of my opinion; for it shows, that persons who sleep much have assimilated less.—If they are fatter, it is because they have lost less, and not because they have digested more; since the contrary has just been proved: but if they have lost less, they have been less in want of reparation; and if this has been the case, they must have digested and consequently assimilated less. The whole of this amounts after all to saying, that if sleepers fatten more than other persons, it is not because they assimilate more, but purely because they lose less.

Sleep acts, then, as it respects fatness, in the same manner as

idleness: now, no one can say that idle persons assimilate more than active ones; we know, on the contrary, that they assimilate less; since we know they consume a less quantity of food; but every one agrees in attributing their corpulence to a much less considerable waste.

Sleep, may be considered as the diminution of all the principal and most apparent phenomena constituting the state of life: this diminution is a want, but one which is far from existing in the same degree in all species, or all individuals of the same species. This, then, is the reason why certain individuals sleep so lightly, that the least noise is sufficient to awaken them; and why certain animals never sleep in a complete manner: such are all birds, the muscular action of which, so far from being annihilated, as in the mammifera, is yet so considerable, that they make prodigious efforts to maintain themselves in equilibrium, whilst the tempest agitates and troubles the weak branch that supports them. See the crane exposed to the wind upon a tower, where it is only supported by one of its claws: does its sleep resemble that of the dormouse or of the sloth?

Now, our own species,—which is of all susceptible of offering the greatest differences between one individual and another, presents also, as regards sleep, almost infinite varieties: with some, it is so profound, that we can scarcely interrupt it; many persons have been rudely agitated in the midst of the greatest bustle, and carried to a considerable distance, without being awakened; while others cannot resist the least noise. Some require eight or ten hours of sleep, and others are contented, throughout the whole course of a long life, with one or two hours. We find some who sleep so tranquilly, that they are ignorant of what a dream is; while others pass their nights in talking, and agitation, and in recalling to mind or repeating aloud what they have said and thought during the day: others do more, and even go so far as to repeat the acts they have been accustomed to when awake; such are somnambulists who only differ from other sleepers in the degree of their sleep.

This is what ought, in my opinion, to be said of sleep; but we must not infer from what happens to persons subject to dreams, and to somnambulists, that this state supposes always a considerable increase in the energy of the brain. We must consider every instance of imperfect sleep as a proof that certain portions of the brain,—certain intra-cephalic nervous apparatus, preserve some de-

gree of irritation, while others lose theirs.* The sensitive expansions, and their prolongations in the brain, are always at rest in such sleepers; but there are some, in whom the portions which correspond to the locomotive muscles are inactive, while those which belong to certain intellectual operations, and to the muscles of speech, do not sleep; such are the persons subject to speaking in their dreams. Somnambulists, who act without speaking, and who nevertheless do things over which the intellect presides, indicate, that with them a part of the intellectual nerves, and the greater number of those of the locomotive muscles, are awake; while the sensitive apparatus is in a state of torpor. Nevertheless, it is certain that these dreamers, and these somnambulists, are not restless during the entire period of their sleep; they have always some hours, either before or after having dreamed, in which sleep is diffused through all the organs: this short rest is sufficient for them. Ought we then to be astonished, that many other persons, who never dream, can, as we have already seen, resume their work after two or three hours sleep, without experiencing therefrom any inconvenience to their health?

But if there are some who can be contented with so short a sleep, many others are to be found whose health suffers from this cause; in the latter the shortness and restlessness of sleep are the effect of a pathological state of some organ. Thus every affection of the brain deranges more or less the continuance and profoundness of sleep: such is hydrocephalus, (chronic cerebral inflammation, attended with effusion) which causes too much, and insanity, (chronic cerebral inflammation, without effusion) which allows but little sleep, or destroys it altogether. Besides, we find many individuals in whom the interruption of sleep, as well as dreaming, is produced by pain of the digestive organs; and others, in whom it depends

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* More conclusive evidence in favour of the plurality of cerebral organs and of their separate and in a measure distinct functions or faculties, need not be required than is furnished by the phenomena of somnambulism and dreaming. No adequate or satisfactory explanation of these could be given on the supposition of the unity of the brain and mind, since in such a case the torpor or quiescence in sleep must be either complete, or entirely wanting, as in the waking state; whereas, in admitting that certain organs of the encephalic apparatus are torpid or asleep, whilst some are irregularly excited, and others again completely awake and competent to the discharge of their functions, we have a consistent and satisfactory elucidation of the cause of dreams or disturbed sleep and somnambulism, with its associated acts, in which are evinced powers of perception and mental combination of a marked character.—Trans.

upon an affection of the lungs, or on some obstacle to the circulation of the blood, and to the regularity of respiration, occasioned by an affection of the heart. The exuberant activity of the genital organs disturbs the rest of many persons during the vigour of age, and after certain excesses. Sometimes it is uncertain whether the cause of these latter derangements comes from the sexual organs, or from the portion, whatever it may be, of the encephalic apparatus which corresponds to them, or from some other viscus. I was consulted by an individual who was almost impotent when awake, but who experienced the most violent erection during sleep; his penis, as soon as he fell asleep, rose with the rapidity of a spring which straightens itself—(such were the expressions of the patient.) This erection was unattended with desire, and was even painful: it persisted during the whole course of his sleep, which it rendered uneasy, and more fatiguing than restoring; it happened without any effusion of semen, and ceased the moment he awoke, with as much rapidity as it came on when his drowsiness commenced. This unfortunate man was yellow, thin, debilitated, digested badly, and presented some signs of gastric irritation. I prescribed to him the treatment proper for chronic gastritis, but I have not learned the result of this plan. I might conclude from such a fact, that sleep is a most active function of the brain; but I am far from wishing to reason in this way: since I select my examples from cases, unquestionably the most numerous, of good health, which are those where sleep is truly a rest; that is, a well-defined and universal diminution of the phenomena that characterize the state of life.

Yet, although sleep be rest, we have remarked that it is announced by certain active phenomena, such as the afflux of blood towards the anterior part of the brain,—the injection of the eyes,—the contraction of the orbicular muscle of the eyelids, whilst that of the levator of the upper lid is slow and difficult,—yawning—and the kind of uneasiness, and anger, which are evinced when this want is opposed.

These phenomena have struck physiologists, who have particularly remarked the occlusion of the eyelids, which is not a relaxation; since the action of the levator is more powerful than that of the orbicular muscle, as is proved by death, which leaves the eyes half open. What must we infer from all these facts?—that the diminution of activity in the organs is a want; as well as their excitement; that the economy becomes irritated against any excitement

carried too far, as much as exasperated at the unmeasured want of it; (we have seen the proof of this last fact in ennui, and will again find it in hunger;) that, to procure the rest which it wants in sleep, it excites the action of certain organs destined to keep away the stimuli which disturb this state; that it has established as a sentinel over its rest, the orbicular muscles of the eyelids, by giving them an alternate action with the other organs, and by forcing them to activity, while the others enjoy a salutary inertia. In fact, of all external stimuli, the most proper to disturb sleep is light. Now, the organization of animals is such, that the uneasiness which constitutes the want of sleep becomes an exciting cause for the orbicular of the eyelids, so that it is forced to act, while the remainder reposes. It will, perhaps, be said, that this is an hypothesis; for my part, I maintain that it is a fact. Do we not see numerous others that are exactly of the same nature? I have noted down the irritating effect arising from a want of moral excitement; the others will be presented in their respective places.

But it will be objected—would it not have been sufficient for nature to have constituted the palpebral muscles in such a manner, that their relaxation might give rise to the occlusion of the eyelids? I answer, that if this had been the case, the operation of keeping the eyes open would have been too painful; they would have closed from the least fatigue;—the expression of the face would have been, at every instant, such as it is at the moment of sleep, and given that appearance called hebetude, and we should have been deprived of sight in numerous instances in which this sense is very useful to us. It is much more convenient for animals, that the open should be the most natural state of the eye; that it should cause no disagreeable feeling, and only become painful when the whole system is in need of immediate rest. What a mistake would it not have been, had we found ourselves deprived of sight when we were in need of locomotion.

This does not appear to me to be idle reasoning; it tends to demonstrate, that the state of activity of a small muscle during sleep, does not lead to the conclusion of the activity of the entire brain, any more than the irritation of the stomach during hunger would necessarily imply a similar irritation in the heart,—or in the cellular and serous tissues, and many other membranes.

But what must be thought of the cerebral engorgement, which is equally active at the commencement of sleep? That it is the means

employed by nature to diminish the innervation which consumes life, in muscular and sensitive movements. We have no idea of the intimate structure of the organs, and much less of that of the brain. Is it then impossible, that this accumulation of blood may take place in vessels different from those whence emanates that influence which determines the phenomena of sensibility, motility, and secretion; so that the engorgement which would ensue in them, instead of exciting, would become the means of preventing these phenomena, by the agency of a kind of antagonism, which would then be no more than a displacement of fluids;—in a word, a true revulsion? Whatever may be the immediate seat of the soporific accumulation of blood in the brain, it still remains demonstrated, that during sleep the phenomena of sensibility and of motility are diminished, as we have shown, in all the tissues of the living body, with the exception of the orbicular muscles of the eyelids, which must preserve their action in order to prevent the admission of light,—the penetrating activity of which would always be opposed to sleep, and would raise the cerebral irritation to the degree constituting inflammation. This is verified by the cruel punishment of the removal of the eyelids, the invention of which makes nature shudder, and is a disgrace to the human species.

Numerous facts, furnished by pathology, can be advanced in support of this proposition. All cerebral irritations increase innervation, so long as they do not produce strong congestions. When, however, these take place, the soporific state supervenes, and innervation diminishes. Narcotics act in the same manner; and I cannot but applaud the fundamental propositions of an essay by M. Fallot, inserted in the second volume of the *Annales de la Médecine Physiologique*,—propositions that are deduced from those I laid down in the *Examen des Doctrines Médicales.* It is thus that men of genius will enrich the truths of the physiological doctrine.

I have said in the *Examen*, that it appears probable to me, that the displacement and revulsion of the fluids, which produce a soporific engorgement in the brain, are determined by the influence of the great sympathetic. I shall examine this proposition when I treat of this nerve, and we shall see whether facts and inductions will render it doubtful, or confirm it in a positive manner. In the mean time, the preceding are the principal among the important facts relative to sleep. I might pursue the examination yet farther, under the head of ages, sexes, and temperaments; but what would

be the use of such minute details on this subject? Who does not know that sleep is longer and more tranquil in infancy than at any other period of life;—that it diminishes, and sometimes becomes null, in old age;—that women can support better the waking state than men, although their strength is less considerable;—that plethoric constitutions, in which fluids abound, enjoy a more tranquil and prolonged sleep than individuals of a dry and nervous temperament;—in short, that an undue exercise of the intellectual faculties prevents sleep, renders it more restless, less renovating, and sometimes destroys it for ever? Besides, I shall have occasion to touch upon these different questions, when I treat of the pathology of sleep. I therefore pass to some general considerations, which are only corollaries deduced from what I have already said on instinct, the intellectual faculties, and the passions.

CHAPTER IX.

COROLLARIES ON THE INTELLECTUAL OPERATIONS AND THE PASSIONS.

Before recapitulating what I have said on the subject of the intellectual functions, and the affections and passions, together with their effects upon the system, I ought to make here the formal declaration, that I do not pretend to offer in this work a treatise on ideology. I point out the source of our intellectual faculties; but do not follow them in their developements in relation to the ideas on which they are exercised. I notice the elements of our passions; but abstain from describing all their shades in an intellectual point of view. I only examine their effects on the system, with a view of discovering in them the causes of, and remedies for, our diseases.

The intellectual domain is immense; and I do not wish to engage in it. I merely desire to point out the line of demarcation between it and the physical; though I am far from flattering myself that I shall ever attain this object. The following is my view of the subject.

I wish metaphysicians, since they so style themselves, would

never treat of physiology ; that they would only occupy themselves with ideas as ideas, and not as modifications of our organs ; that they would never speak either of the brain, or of the nerves, or of the temperaments, or of the influence of climates, localities, and regimen ; that they would never inquire whether there are innate ideas, or whether they come through the medium of the senses; that they would not undertake to follow their developements according to age or the state of health ; for I am convinced that they cannot reason justly on all these points. Such questions belong to physiologists, who can unite a knowledge of the moral nature with that of the structure of the human body.

It is only *in relation to sacred and profane interests* that metaphysicians can examine ideas. This field is very extensive; it comprehends the art of reasoning, considered in itself; next religions, laws, customs, and manners denuded of every physiological consideration; politics and the arts; the description and classification of bodies; the description of nature; that of thought in writing, and calculation considered in an abstract manner, or applied to the laws of inert bodies, as in natural philosophy properly speaking, and in chemistry ; the picture of thought in style; that of our feelings, in the arts, music, and the exercises of the body, such as dancing and all the gymnastics, &c. The domain that I assign them ought to be sufficient for their meditations; for all our actions which are the consequences of our thoughts, have very extensive influences over our destiny. Let metaphysicians calculate, let them examine thoroughly these influences, and let them deduce from them rules of conduct, always founded on particular or general interests. They can accomplish this without leaving the subject of metaphysics ; but let them never seek the source of the influences alluded to in the action of the organs, nor their effects on the harmony of the functions; otherwise their labour will be of no avail.

It is possible, that particular circumstances may oblige them to introduce physiological considerations in their calculations ; such are the cases in which it is necessary to estimate the influence of certain laws or customs, in relation to temperature, the nature of the soil, prevailing diseases, &c. ; but then they should avail themselves of the experience of physiologists and physicians.

It will, perhaps, be answered, that if metaphysicians confine their meditations to these subjects, they will only be moralists. I maintain the contrary. They may, after having distinguished *simple*

ideas, which are representations of the bodies in nature, from *abstract* ideas, which are only *conclusions*,—that is *judgments*,—discuss with ease the faculty we possess of recalling those ideas,—which constitutes *memory;* of foreseeing future impressions,—which is *prescience*, and gives rise to prescient judgments; of feeling those impressions more or less acutely, and representing them with more or less force and truth,—which constitutes *imagination;* they can, I say, examine whether abstract ideas of movement and rest, of attraction and repulsion, of formation and destruction, of growth and diminution, of extent, height, and depression;—of greatness and smallness, of beauty and ugliness, of justice and injustice, of divine, spiritual, and temporal right; of power, sacredness, profaneness, hatred, friendship, fear, audacity, benevolence, harshness, sensibility, cruelty, pride, vanity, jealousy, envy, &c., represent qualities inherent in objects, or modifications of our consciousness relative to general or particular, real or imaginary relations; or to true or false, eternal or purely accidental interests. They may also point out how one judgment produces another;—establish the advantage or disadvantage of considering all these questions rather under one point of view than under another; in a word, they may exercise themselves in discovering the truth under the deceitful masks with which the science of ontology, (that despotic ruler of social life,) has covered it. Such is the task I have imposed upon myself relative to medicine; and it is with a view of continuing its execution, that I am about to present a short sketch of the passions, considered in their relations with the state of the organization of man.

I. As organs have been given to man, placed in the midst of the universe, there are two general sources of perceptions; (*a*) the wants; (*b*) the external bodies destined to gratify them.

II. The wants have their source in the viscera; from these certain impulses proceed, reach the cerebral centre, and keep it in a waking state. If man recognises the external body required by his viscera, there is a determinate desire; if he does not recognise it, this desire is vague and confused. These phenomena are purely instinctive.

III. The wants are either physical or moral.

IV. The physical wants are those (*a*) of calorification, (*b*) of respiration, (*c*) of nutrition, (*d*) of the evacuation of the residue of nutrition, (*e*) of exercise, (*f*) of rest and sleep, (*g*) of self-preser-

vation, (*h*) of generation, (*i*) of the expulsion of its product, (*k*) of the preservation of this same product. These phenomena are still instinctive.

V. Moral wants, though apparently very numerous, seem to me to originate from a single source,—the necessity in which we are placed of observing all the bodies in nature, and of comparing them with ourselves: I define it the *want of being excited to thought.* This phenomenon is purely intellectual.

VI. The external bodies that produce an impression upon us, relate either to our physical or moral wants.

VII. External bodies in relation with our physical wants, are, (*a*) external heat for calorification, (*b*) oxygenated air for respiration, (*c*) food, and water either pure or charged with some principles for nutrition, (*d*) a proper place for defecation, (*e*) a convenient space for exercise; but numerous external bodies develope and fortify within us the impulse which directs us to gratify this want; (*f*) a proper place for rest and sleep, (*g*) animated or inanimate bodies to repel the danger which threatens us, and cause a cessation of our pain, or room to enable us to escape, (*h*) an individual of our own species, but of a different sex, for the want of generation, (*i*) a proper place for the expulsion of the product of the latter, and an individual who can assist the woman in labour, (*k*) all animated or inanimate bodies which can concur to the preservation of our children. These phenomena have their source in instinct.

VIII. The external bodies in relation with our moral wants, are as numerous as the objects in nature; for we do not content ourselves with observing those which serve for our physical wants: our restless curiosity pervades the whole universe, and feasts itself on every impression thence derived, either directly or indirectly. This is the principal characteristic of man, and it is purely intellectual.

IX. Instinctive impulses reach incessantly the centre of perception by means of the nerves, which from all parts of the body, converge towards the brain; and this transmission takes place even during the absence of external bodies proper to gratify the wants.

X. As soon as the external bodies, adapted to the gratification of a want, act upon the external surfaces of relation, they produce an impression which is transmitted to the brain.

XI. Impressions made by external bodies, agitate instantly the

entire extent of the nervous system, and in this way strongly affect the viscera.

XII. If some viscus be interested in the impression, it evinces its interest to the centre of perception by a sensation which the latter refers to the said viscus, and the individual is instinctively solicited to seize the body which has made the impression, if it be favourable to his system; to repel or to fly from it, if it be injurious.

XIII. The intellect observes these relations; but they have been pre-existent to its developement; it cannot put a stop to the acts which are commanded by certain wants, and only suspends them; but there are numerous others which it can prevent, even at the expense of the life of the individual.

XIV. If the impressions made by external bodies do not affect any viscus in an immediate manner, they remain in the purely intellectual domain, as serving to gratify the *want of thought.* It is thus that one may occupy himself with the arts and with abstract subjects, without feeling any internal sensation. But, although these impressions do not cause any sensations in the viscera, nor instinctive impulses, they nevertheless agitate the whole nervous system, and consequently reach the viscera. The proof of this is, that such an impression, which causes no sensation in certain states of the viscera, occasions sensation in others.

XV. The impressions of external bodies, which at first only interest the *want of thought*, are not long, however slight they may be, in interesting the viscera, by renewing, through the means of memory or prescience, ideas relative to first wants.

XVI. When the impressions of external agents are very strong, if they are not transmitted to the viscera by means of other wants, they reach them, by that of self-preservation, or by ideas of comparison which always awaken self-love.

XVII. It results from the preceding propositions, that intellect is always stimulated by the viscera, and the viscera by the intellect; and that they never act separately.

XVIII. The two sources of affections and passions, are pleasure and pain; pleasure produces *love*, and pain *hatred*.

XIX. I call *passion* a continued state of love or hatred, which masters the intellect, and constantly determines a series of acts which tend either to prolong the pleasure, or to cause a cessation of the pain that produces them. When love and hatred are feeble,

or of short duration, I name them *inclinations*, *tastes*, *disgusts*, *aversions*, *affective movements*, or simply *affections*.

XX. Love and hatred have for their objects, either the impression itself, or the cause of the impression.

XXI. When love and hatred are directed towards the impressions, the affections and passions which we feel have ourselves for their only object; because it is always in proportion to the love of ourselves, that we love or hate the impressions: such is avarice,—a passion founded on a false judgment, concerning the means of rendering ourselves happy; but which still has self-love for its basis.

XXII. When love and hatred have apparently for their object the causes of the impressions, this object is not the only one; for it is through a love of ourselves, that we love or hate other objects. There is then, here, love of ourselves, in the love or hatred of the causes of our impressions.

XXIII. When, in a passion, we sacrifice ourselves either in favour of certain causes of our impressions, such as our equals, or to procure for ourselves the pleasures of a future intellectual life, or to free ourselves from an actual pain brought on by a moral cause, such as ignominy, we are forced to this by our self-love; but then, instead of making our happiness consist in the *gratification of the wants of instinct*, we place it in certain enjoyments relative *to the necessity of thought*. It is usually the love of ourselves, in the comparison with our like, which leads us to this sacrifice. Hence, this love is an enjoyment purely intellectual, and which can only exist in our own species; because, when an animal sacrifices itself to the preservation of its young, it does not foresee its own destruction. But, when we destroy ourselves in order to escape from physical pain, it is an aberration of the love of ourselves, and instinct triumphs over intellect.

XXIV. To determine the true sense of the expressions used to convey an idea of our affections and passions, we must consider the sentiments of love or hatred which constitute them; first, as it respects the nature of the want gratified or opposed; secondly, as relates to time.

XXV. If we consider the affections and passions, in relation to the nature of the wants, we find (*a*) as regards instinctive wants, first, the love of ourselves in that of the feeling of this want, when it is agreeable,—as for example the desire of coition; secondly, the love of ourselves in a hatred of the sensation of the want when it is

painful; for example, hunger; thirdly, the love of ourselves in that of the external body proper to gratify the want; but, when this body is one of our own species, the affection or the passion seems only to have this body for its object; fourthly, love of ourselves in the hatred of the external cause which opposes the gratification of the wants; but, when this cause is a being like ourselves, the affection or passion appears only to have this cause for its object. (*b*) As regards the want of moral excitations or of thought; first, the love of ourselves in that of the sensations which agreeably exercise our intellect, because we are satisfied with ourselves: this is *gratified self-love;* it is the source of ambition, of the love of power, of command, and of instruction, of the pleasure we feel in destroying, as well as that we find in benevolence: secondly, the love of ourselves in that of the causes of the impressions which gratify our self-love; and, if these causes be individuals of our own species, the affection or passion appears to have them for its object; hence arise *friendships*, founded upon what is called a conformity of disposition; a fondness for the instruction we receive, that is a love of our instructors; hence arises the love for flatterers, as well as affection for those to whom we render some service: thirdly, the love of ourselves in the hatred of the external causes of the sensations, and the series of ideas which fatigue our intellect; and when these causes are individuals of our species, the affection or passion appears to have them only for its object; hence arises the hatred for rivals who have some advantage over us in science, the arts, riches, power, great actions, &c.: this is called *jealousy*, and *envy*. This hatred is almost always concealed, because our self-love is humbled by the confession of a feeling of jealousy or envy; we then do all in our power to persuade others, that our hatred has for its object the ideas, labours, and actions of our rivals, only because they are bad.

XXVI. When we consider affections and passions in relation to time, we must refer them to the present, to the past, and to the future: (*a*) if we consider them in relation to the present, they are such as we have already described them. (XXV.) (*b*) Considered in relation to the past, they enable us to observe, by the aid of memory, first, as respects love, the remembrance of agreeable sensations, whatever may have been their cause,—a remembrance which is an actual pleasure, and which produces the love of past impressions, and that of their cause; secondly, as respects hatred, the re-

collection of disagreeable sensations,—a recollection which is an actual pain, and which produces a hatred of former impressions, as well as of their causes; thirdly, as respects the comparison of former pleasure with present pain, and past pain with actual pleasure, we find alternate sensations of pleasure and pain, producing alternately a love and hatred of past and present impressions, and the love and hatred of their causes; hence arise *regrets* which torment us, as well as *rancour, inveterate hatred, &c.* very complicated passions, in which the love of ourselves is concealed in a thousand ways more or less specious, but which cannot impose on the true observer. (*c*) Considered in relation to the future, our affections and our passions offer us by means of *prescience*, first, in respect to love, the prospect of agreeable sensations, whatever may be their cause, a prospect which is an actual pleasure, and which produces a love of the impressions, as well as of their causes; hence arises *hope:* secondly, in respect to hatred, the prospect of disagreeable sensations, which is an actual pain, and produces a hatred of future impressions, and a hatred of their causes; hence arise *fear* and *despair:* thirdly, in respect to the comparison of past or present pleasure with future pain, and of future pleasure with present pain, alternate sensations of pleasure and pain, which produce alternately the love and hatred of past, present, and future impressions, as well as the love and hatred of their causes; hence arise passions extremely complicated, in which we again find *regret, rancour, fear, hope, discouragement, despair*, and all the moral consequences they give rise to. *Avarice* is naturally referred to this series; because this passion is composed of the fear of the future, founded on the observation of the present and the recollection of the past.

XXVII. *Joy* is always the effect of pleasure, and consequently of love; *sadness* is invariably the effect of pain, and consequently of hatred. These constitute, therefore, two passions which are, in a measure, *general.*

XXVIII. *Anger* and *flight* are two instinctive movements of reaction; having for their objects,—the first, to repel the cause of pain; the second, to avoid it. Both are founded on hatred; but anger being a sudden exaltation of hatred, forms a part of the movement which constitutes this passion; whereas the determination which produces flight, can only be considered as one of its effects, and not as the passion itself.

XXIX. Anger can be developed in all kinds of hatred; but its

object varies; for it may be directed either against the sensation itself, or against its cause. When directed against the sensation, it is more or less reflected upon the men or things that surround the individual. Hence arise the fretful temper, and the abruptness, of persons who suffer. When anger is directed against some determined object, it is less reflected upon others.

XXX. Anger belonging to all kinds of hatred, whether produced by past, present, or future causes, gives them always an impetus more or less marked, and thus causes a change in the name of these passions; from this arise, *jealousy*, in the love of the sexes; *emulation*, *confusion*, *envy*, in offended self-love; *pride*, *indignation*, in the same passion; *transports*, in despair; *impatience*, in the expectation of pleasure; for the latter is a pain, which produces movements of hatred; impatience also, in all kinds of pain, either from physical or moral causes; *fanaticism*, in the hatred of persons who irritate our self-love, by opposing obstacles to enjoyments of an intellectual origin, and relating either to forms of worship, to power, to any sect whatsoever, to the arts, &c.

XXXI. All the passions are susceptible of being communicated; and this communication is the effect of imagination, or of the faculty with which man is endowed of representing to himself, more or less keenly, the impressions he has received from others, and of substituting himself in the place of him who actually is or has been enjoying or suffering, or who is hereafter to enjoy or suffer: hence arise *mutual enjoyment* and *compassion*—new proofs that we refer every thing to ourselves, and that self-love is the sole origin of our affective movements and of our passions.

I shall develope more fully the following propositions, on account of the discussions to which they give rise at the present day.

XXXII. The affections and passions are always composed of two elements; the exercise of thought, which furnishes the *primum mobile;* and the visceral sensations, which afford the means. Without lively sensations referred to the viscera,—without impetuous movements in their tissues, thought would not produce those extraordinary acts that characterize the passions; because the will would not be led away; there would only be feeble suggestions, and no action. It is thus, that passions escape with the blood, and that the most perfect intellects can produce nothing which resembles passion in men endowed with anemic constitutions. In such subjects the affections only can exist.

XXXIII. Prevent thought, the passion it excites is destroyed; exalt the action of the viscera, the passion increases; weaken vital action in the viscera, the passion diminishes; impair the state of the viscera, the passion is perverted or destroyed.

XXXIV. When the passion has lost its sensitive aliment by an incipient alteration of the viscera, though the series of ideas which excited it may be kept up by external causes, yet they no longer produce any other than weak affective movements; and there remains hardly any thing but intellectual operations.

XXXV. The passions which are founded on instinctive wants are the most easily destroyed by the modification of the viscera; such is sexual love, which disappears with the progress of age, although thought has lost but little of its energy. Those that depend upon a want of thought, resist more powerfully this modification. It is thus that friendship survives certain deteriorations of the organs; but friendship is then nothing more than an affection.

XXXVI. Were nothing proved, but the destruction of the passions, affections, and even of the purely intellectual faculties, by a profound deterioration of the viscera,—the brain remaining sound—it would be sufficient to attest, that this organ can do nothing without the aid of the others. How could it act, since its instruments would be destroyed? Now, the instruments put in action by the brain, are not merely the muscles; but this organ also excites the visceral movements, in order to react upon itself, and determine it to overcome the obstacles which ideas, foreign to those of the passion, incessantly oppose to the will. But, on the other hand, if the irritations excited by the brain in the viscera act upon it, why should not those, originating from any other cause, produce the same effect? Surely, they do, and it is of little consequence by what means the viscera are irritated; it is sufficient that they be so, in order that the brain should also become affected,—that a certain series of ideas should be necessarily excited, and that the will should be more or less led away, according to the intensity of the visceral irritation. It is thus that nascent love only determines hesitating steps; whilst, when more decided, this feeling, having become a passion, triumphs over all opposition; that the lover satiated with enjoyment, becomes indifferent to the beloved object, and recovers all his ardour, when the spermatic plethora is re-established. Let those, who deny a necessary concourse of visceral influences in the passions, examine a man whose stomach is excited

by alcoholic drinks; they will see him fly into a passion on the least contradiction, which would scarcely have moved him had his thirst been quenched by water only. If they pretend, that alcohol acts here upon the brain alone, they will advance an absurdity; for, in certain states of gastritis, a broth, and a simple mouthful of meat, are sufficient to produce all the effects of intoxication. If this fact be not sufficient to convince them, let them examine the same man suffering greatly from hunger, and they will find him as irascible as when drunk, and often more intrepid and cruel. Have they not then remarked, either in facts before them, or in history, the frightful exaltation of all the feelings of hatred and fury,—the abolition of those of pity, compassion, generosity, and of filial and paternal love, which constantly take place in assemblages of men exposed to the horrors of famine? Have the cerebral eminences enlarged under these deplorable circumstances? I have already said, that there were always, in these cases, exceptions honourable to the human species: they are referrible to the intellectual operations, which overpower instinct; but in producing this effect, the intellect still excites the passions: this is the subject of the succeeding proposition.

XXXVII. The passions of a purely intellectual origin, can be raised to a great degree of intensity only by the organic sensations and movements which the exercise of thought determines in the tissue of the viscera. This law is founded on an indisputable fact, already sufficiently proved in this work, if there did not exist some men whom self-love engages to feign an ignorance of the arguments by which their sophistry has been refuted. This fact is, that love, hatred, and anger,—feelings without which those passions denominated *intellectual* could not exist, are necessarily accompanied with sensations and movements in the viscera.. Consequently, in cases of opposition offered by the intellect to the voice of physical wants, thought excites in the viscera a sensation different from that produced by the want: it is either a pain or a pleasure, but of a very different shade from the pain and pleasure produced by the want; in the same way that the visceral pain of anger is different from that of terror, and that the visceral pleasure of gratified self-love differs from that produced by friendship, or maternal tenderness. Why should these differences exist, if they were not necessary? And, if they are necessary, is it for any other object than to react upon the intellect, and assist it in resolving on the acts which

the actual series of thoughts may require? Now, the fact proves this to be their destination; since old and feeble men, simply think, and do not act. Hence those who maintain the independence of the brain during the indulgence of the passions, support a great error. It is, therefore, very certain, that intellectual operations take place without developing sensations in the viscera, only when thought is exercised upon impressions that are unconnected with the first wants, or which interest them only in a distant manner. See propositions XIV., XXV., and XXVI.

It may be seen by this analysis, that I make no pretension to judge of ideas as such,—that is, in their relations with the objects they represent; I only consider them in connexion with the organs, and it is right I should do so; since the movements of pleasure and pain, of love and hatred, cannot exist without affecting the tissues, and consequently without exposing the functions to some derangement. It is for this reason, that I have taken the liberty of classing ideas in the order of such of these movements as they can excite, and I abandon all interests, either spiritual or temporal, sacred or profane, as constituting no part of the science of medicine.

CHAPTER X.

OF THE MANNER IN WHICH THE EXERCISE OF THE INTELLECT, AND THE AFFECTIVE MOVEMENTS, AND THE PASSIONS, BECOME CAUSES OF DISEASE.

It is constantly repeated in medical writings, that intellectual labours and the passions produce derangements in the organs; and still it is attempted to limit all the intellectual and affective phenomena to the brain. It is agreed, that the encephalon acts on all the viscera, and physicians refuse to these a power of reaction upon the encephalon capable of modifying thoughts and affections. They affect to suppose, that I place the passions exclusively in the viscera, in order to procure themselves the pleasure of an easy refutation, and they do not perceive the vagueness and absurdity of such a reproach. Where, indeed, is the physiologist who can, at the present day, say unreservedly that the passions are independent

of the brain? Would it not be as absurd to suppose a man the least acquainted with anatomy, capable of advancing such a proposition as to say that a reasonable person is persuaded, that one can think after having been beheaded? This method of attributing absurdities to those who entertain an opposite opinion from that which we profess, in order to divert one-self with refuting them, is the characteristic of a superficial, or at least of an inattentive mind, and cannot mislead sensible persons. Nothing is wanting to the triumph of these dull wits, but that they should announce to the public, on seeing the part I have attributed to the encephalon, that their objections have made me alter my opinions on the subject.—Now, to spare them this new inconsistency, I refer them to my thesis on hectic fever, published in 1803. I am, it is true, very far from adopting, at present, all the medical principles it contains, but I admit those propositions which relate to the intellectual and affective faculties. They will there see in substance, what I have just developed in the preceding chapter,—that the passions are composed of two elements, the exercise of thought, which belongs to the brain, and the internal sensations, accompanied with organic movements, which the individual perceives more or less distinctly in his viscera. I never thought of professing any thing else; and this may be proved by all those who have attended my lectures on pathological physiology. But I have already sufficiently spoken of myself; and will now resume our subject.

When examining the action of each of the senses in particular, I pointed out in what manner impressions produced by external agents might derange them; that is to say, we have seen in what manner impressions became causes of disease, at the instant of their passage over the parts of the tissue, through which they penetrate to the interior. It becomes us now to follow them in their course, in order to discover the causes of the diseases to which they give rise in these interior parts.

As soon as they have reached the tissue of the brain, impressions are immediately reflected through the whole nervous apparatus, and we cannot, at first, foresee in what part of the vast system they will develope a perturbating irritation. Idiosyncrasy, the relative predominance of action of certain viscera, an accidental focus of sensibility or phlogosis, often determine its location. In other cases we have no data for the solution of this question. We only know that the organs intrusted with the principal functions are af-

fected in preference, and that they reflect the irritation upon the other tissues. To treat this subject with some degree of method, it becomes necessary to establish the following divisions: 1. Lesions arising from the exercise of the intellectual functions without passion; 2. Those arising from the exercise of the intellectual functions with affection or passion. It is also necessary to examine the latter, (*a*) in reference to the vivacity of the passion, (*b*) in reference to its nature; at the same time determining which of the lesions, among those we have just alluded to, belong to each of the passions in particular.

Section I.—*Of the manner in which the Exercise of the Intellectual Faculties disorders health.*

In the lowest grade of the intellectual operations, that in which thought produces the least disorder in the economy—whether on account of the nature of those ideas which do not relate to the first wants, or at least to wants actually urgent, or whether in consequence of the individual constitution—sudden perturbations never arise; the troubles are slight, and the organic alterations are only slowly formed; the brain is then first affected, and the other tissues only suffer after a period of greater or less duration. It is thus, that purely intellectual labours, without any mixtures of passions, such as the abstract sciences, which are very numerous,—the description and classification of the bodies in nature, or the products of art,—the descriptive sciences,—mechanics,—the forced exercise of memory,—the labours of the copyist, the analyst, or the historian; philology, bibliography,—in a word, every thing which only exercises thought by requiring a lively and constant attention, keeps up in the encephalon a state of vital erection by which it is sensibly transformed into a permanent focus of irritation. Under these circumstances, the head becomes heavy and painful; there is an inclination to sleep, or else an obstinate state of wakefulness is established; and inflammation of the brain, either acute or chronic, as well as hæmorrhages of this organ, are on the point of being developed. They appear very often under the forms of insanity, paralysis, idiotism, and even apoplexy.

The nervous expansions of the domain of relation, undergo a simultaneous exaltation of action;—the individual becomes irritable, and convulsions are easily excited; the sight is altered by the

effect of inflammation or by a collapse which terminates in amaurosis, commonly called *gutta serena*. In time, the same irritability is established in the ganglionic nerves; and the movements of the viscera as well as those of the vascular apparatus in general, become disordered under the influence of the slightest causes, with as much facility as the movements of the locomotive muscles. It is thus that many constitutions which were not originally nervous become so; and those which were so before, acquire a degree of mobility, which harasses the patients, and becomes the torment of the physician.

Having acquired this degree of irritability, individuals easily contract inflammations through the influence of food, drinks, atmospherical vicissitudes, &c. These inflammations are rarely very intense; but in return they are difficult to cure; because they are renewed very easily, and the health becomes at last completely ruined.

Another modification of the system, is sometimes associated with the cerebral irritation produced by the excessive exercise of thought. It is a state of debility in the muscular apparatus, a sluggishness of digestion, accompanied with costiveness and with a remarkable languor in the cutaneous transpiration. Hence result a multitude of evils; for food, by remaining too long in the upper region of the digestive canal, finally developes there an irritation. This irritation is always circumscribed; and as it is but slight at the commencement, it is easily removed by purgatives and tonics; but it never fails to reappear, if the same causes continue to act. A period arrives, however, when those means that usually remove, now aggravate it, and the stomach is finally no longer in harmony with the stimuli necessary to support life; hence result gastro-enterites, with hypochondriasis, melancholy, &c.

There are some robust and plethoric constitutions which become neither nervous nor weak, by the influence of study: they only experience such effects as arise from a want of exercise, joined to a too considerable hematosis; hence plethora and obesity become the torment of these persons, when they have attained the term of their growth, and especially when they have arrived at the age of manhood. At this period the hæmorrhoidal irritation and the sanguineous engorgement of the viscera are established; whence result, for the digestive canal, gastro-enterites, which do not proceed beyond the small intestines;—for the liver, a painful tumefaction,

with excess of bilious secretion ;—for the lungs, a state of fulness and dyspnœa :—for the heart, hypertrophy and aneurism ;—for the brain, a soporose and apoplectic disposition.

In all those who study too much, the skin easily becomes affected with herpetic eruptions ; either from the languor of perspiration, which leaves this membrane covered with an irritating deposit, from congestions, or from the violent afflux of blood which takes place from time to time in its tissue, when the external temperature is raised suddenly to a high degree, by the influence of the sun, or by that of an artificial source of heat.

Irritability, united with plethora, produces also other disorders, such as gout, erysipelas, &c. ; but as other causes, besides intellectual labours, may give rise to them, their etiology will be better placed in the physiological history of the digestive and circulating organs, on which they are in a more immediate manner dependent. It is sufficient to have mentioned them here.

Intellectual labours give rise, in early life, to effects corresponding with the actual state of the individual constitution. Thus the brain, the growth of which is not complete, acquires, by the exercise of thought, an extraordinary energy and volume ; the moral faculties become truly prodigious ; but this advantage is sadly counterbalanced by cerebral inflammations, which give rise to hydrocephalus, and by a languor in the rest of the body, the developement of which remains imperfect. The muscles are slender and weak,—the chest narrow, the abdomen large,—the mucous membrane of the stomach perpetually irritated,—the skin without energy, and always pale ; because study necessitates seclusion in places sheltered from too vivid a light. The inconveniences arising from a want of exercise, are therefore united to those which result from a super-excitement of the brain and its dependencies. It is easy to conceive what a number of evils must result from a kind of life so little in harmony with the wants of youth ; hence we rarely see all those prodigies of premature intellectual education prospering.—If encephalitis does not carry them off, they infallibly perish with gastritis or scrofula : most generally, all these evils oppress them at once ; and, if they do not sink under them in infancy, they carry along with them, in mature age, an irritability which does not allow of their resisting the morbific influences in the midst of which man is necessarily forced to live. They are seen to decay and die in the prime of life, if they are not destroyed, in spite all the efforts

of the art, by the first violent inflammation that attacks them. If the simple exercise of thought can occasion so many evils, what will it not do when the passions are associated with it! This important question deserves to be treated in the greatest detail.

Section II.—*Of the Morbid Effects of Lively Emotions and of the Passions, united to the Exercise of the Intellectual Faculties.*

The least powerful effect of the passions is to produce that nervous irritability which we have seen to result from the excessive exercise of the intellectual faculties: but how many other evils may not be the consequence of it! To treat them with order, we must, as we have already proposed, examine the effects of the passions according to their degree and nature.

In the most intense degree of the affections and passions, we find primarily an irritation of the encephalon, incomparably stronger than that which accompanies the exercise of the intellectual faculties. The passions can therefore produce, at the instant we feel them, violent cerebral congestions, capable of occasioning death, and this accident may take place without the occurrence of any rupture of the vessels, or any sanguineous exhalations. It is thus that violent transports of anger, surprise, terror, and joy, have caused sudden deaths, after which no apparent changes were found on dissection. I say apparent, for I am persuaded there must have been some in the brain, and that if they have not been perceived, it is because sufficient attention has not been paid to the state of the cerebral pulp, which in these cases is commonly much harder and more injected with blood than usual. Now, I consider such a state to be a true organic lesion, produced by an extraordinary afflux of blood to the animal matter of the encephalon, and that this fluid, penetrating too deeply into a texture of such extreme delicacy, has produced a true disorganization. Do we not see, in fact, an alteration very similar to this after phrenitic deliriums? Formerly, it did not fix the attention of practitioners; but now, when pathological anatomy is more advanced, we are aware of the degree of importance that should be attached to it; and if it has been found in a person carried off by a transport of joy, love, or enjoyment, or by fright, we should not fail to refer to it the cause of death, instead of attributing the latter, as was formerly done, to an unappre-

ciable modification of the whole extent of the nervous system. Another circumstance that leads me to adopt this explanation, is, that whenever our feelings are extremely lively, we perceive distinctly the cerebral congestion, which seems to distend excessively the cavity of the cranium, to raise its vault, and which often goes so far as to obscure our ideas. Now, from this state to a complete abolition of the cerebral functions, there is but one step, and it is easy to conceive that this may be passed with facility.

Sudden deaths, produced by violent passions, may likewise depend on the spasmodic state of the heart, which remains contracted, and ceases to keep up the action of the brain. In such cases, the sick perish discoloured, and in a state of syncope. An extraordinary irritability of the central muscle of the circulation, can alone explain this kind of death ; and I do not doubt that it has often occurred. This accident might be distinguished from the preceding, by the suffocating anguish,—by the precordial oppression,—by the paleness of the face, and the weakness of the pulse, opposed to a lively colouration of the face, the turgescence of the veins, and a fulness of the pulse, which always precede deaths determined by the congestion of the brain. This distinction is important; for bleeding, which might restore life in the latter case, would be fatal in the former, and should give place to the diffusible stimuli, called *antispasmodics*, which might solicit the contraction of the heart.

Violent percussions on the epigastrium, the often horrible pain of gastric inflammations, may determine sudden deaths. Hence, I should not be surprised, if sudden fits of the violent passions were to occasion death, by the nervous irritation of the epigastric centre. For this, it would be sufficient, that the sensibility of the mucous membrane of the stomach should be exalted by a state of inflammation, at the moment when thought excited an extraordinarily violent passion; because irritation of the gastric papillæ keeps the whole of the abdominal nervous apparatus in an extreme state of irritability. If this case could be suspected by the commemorative signs and the seat of the pain, which often bears the name of *agony*, bleeding and cold water might perhaps prevent death; but there are circumstances, in which it is so sudden, that medical aid is totally unavailing.

Such are, in my opinion, sudden deaths, *purely nervous*, which may be produced by an excess of the passions; but there are others which I call *vascular*, although they owe their primary source, to

the influence of the nervous system: it appears to me, that they ought to be placed after the preceding.

The first still belong to the brain, and may be classed among apoplexies: they are occasioned either by the rupture of the vessels which are distributed to the cerebral substance, where we find, after death, masses of fluid or coagulated blood, or by the exhalation of this fluid, either in the tissues of the pia mater, which is most common, or at the surface of the arachnoid; but this disorder is rarely the instantaneous product of an acute passion, unless there existed a prior irritation of the membrane. It is readily perceived that these kinds of extravasations are very analogous to the rapid hardening of the brain, of which we have already spoken; since they are always produced by an extraordinary afflux, and by the deviation of the blood from its accustomed route.

The second kind of sudden deaths, which I call *vascular*, is occasioned by the rupture of the heart or of a large vessel. It is usually in the chest that the vascular trunks are ruptured by the effect of strong fits of passion; except when the ventral aorta, or some other vessel of the abdomen, is already predisposed to it by a partial inflammation of its coats, or by an aneurism; and when it is the heart which is lacerated, it yields sooner at the right auricle than at its other cavities, because this part is the weakest. This organic lesion, it appears to me, ought to be explained in the following manner. The too acute feeling of the passion produces a constriction of the right ventricle, which refuses to admit the blood of the auricle; and this fluid, constantly propelled by the torrent which comes from the vena cava, overcomes the resistance of the auricle. It is easily conceived, that if rupture be possible, aneurism is still more so, as has been but too often demonstrated by observation. It is also seen, that a heart, the ventricles of which are already in a state of aneurism, may be ruptured by the influence of a violent passion; this arises from the circumstance, that the irritation having accumulated and retained the blood in the brain, lungs, and viscera of the abdomen, the two ventricles can no longer propel, in their respective arteries, the fluid with which they are filled, and on which they act with so much more energy, as the brain, stimulated by the passion, does not cease to excite them to contraction. If any one should think it strange, that I make the brain act upon the parietes of the heart, I would ask him, if he has never experienced palpitation in consequence of any moral affection, and if this

palpitation can be otherwise explained than by the direct influence of the centre of sensations upon the muscular tissue of the heart. I shall resume this subject, when treating of the apparatus of circulation.

After sudden deaths from passion, which have been determined by the rupture of large internal vessels, I must place those which depend on hæmorrhagies by exhalation; they are, it is true, less frequent and sudden, but we have examples of them. I have read in a work, that a lady, who was sitting on the grass, felt a living frog fall in her bosom from the claws of a bird of prey which was passing over her; she was seized with so copious an hemoptysis, that she only survived a few minutes; so true is it, that moral affections reverberate with the rapidity of lightning, in all the sensitive tissues of the system. Hematemesis is also the effect of strong passions; and uterine hæmorrhagies are frequently occasioned by the same causes. I have often seen blood rush from the nose in anger; and we have examples of sudden cutaneous hæmorrhagies, determined by moral affections.

If the blood can be extravasated, either by rupture, or by exhalation upon the membranes of relation, it can also be propelled from the vessels that contain it into the cellular tissue, and in the large parenchyma; but this disorder is seldom followed by death. We frequently see, in sanguineous women, large sub-cutaneous ecchymoses, (*morbus-maculatus* of certain authors,) occasioned suddenly by strong moral affections; and we know, that hemoptysis, which may depend on the same cause, is almost always accompanied with, and even preceded by, an extravasation of blood in the areolar tissue of the lungs: examinations after death have manifested this kind of disorganization. In a word, moral affections may produce extravasation of blood into parts which correspond with the brain, either in the nature of their functions, or from the effect of an inflammation, by which, from being insensible, they have been rendered irritable and mobile even to excess. It is thus, that the pleura, the peritoneum, and some synovial membranes of the large joints, are liable to hæmorrhagies from the influence of powerful affective commotions, when these tissues are rendered excitable by a certain degree of inflammation.

After the influences of the passions acting upon the vascular system, we must treat of those that are directed to the secretory apparatus; since we proceed from disorders that are most promptly

produced to those less so, in order that we may conclude by those alterations which advance slowly, and which, on this account, have been less noticed than any others.

There is no secretory organ, the action of which cannot either be increased or diminished, or its product altered by the influence of thought in that state of exaltation called passion. We know with what facility fear, horror, surprise, and anger, at the moment of their onset, may suppress sweat, and even what is called insensible perspiration. This suppression is nothing by itself, when it is instantly replaced by the secretory action of the kidneys; but either from the insufficiency of this vicarious action, or from some other cause, morbid irritations are often developed after these accidents. It is sufficient merely to indicate them here, since they resemble those that are produced by cold; and because we intend to treat of them in speaking of the functions of the vascular system.

The kidneys are not less affected than the skin, in strong moral affections; fear increases their secretion in a singular manner, so much so indeed, that it is hardly conceivable whence can issue the astonishing quantity of urine furnished, in certain cases, by these organs. Every one knows, that the milk is suppressed in nurses, during paroxysms of the strong passions; and that sometimes it becomes so irritating, that children who suck plentifully of it are affected with colics, and even with violent gastrites. We have studied the influence of the passions on the secretion of tears; which are also seen to become burning, and so acrid as to inflame the conjunctiva, the eyelids, and even the cheeks.

The saliva is secreted and even projected with much force into the mouth, by the idea of an article of food which flatters the taste; and anger, as well as the venereal orgasm, communicate to it poisonous qualities capable of provoking convulsions, and even madness, in those persons bitten by a man agitated with the transports of these two passions. Every one knows with what energy ideas of love act upon the testicles: the semen is then so abundantly formed in certain subjects, that it chokes up the seminal vessels, the epididymis, and the vesiculæ seminales; and the mere influence of thought suffices, in many persons, to determine its ejaculation, even during the waking state.

Shall I speak of the action of the liver? It is so powerfully influenced by the exercise of thought in lively moral affections, and especially in anger, that bile flows abundantly into the duodenum,

whence it sometimes passes into the stomach and produces vomiting; or is poured into the intestines, stimulating them to such a degree, as to cause colics, diarrhœas, and even inflammations.

We cannot judge so well of the changes suffered by the pancreas; but as it is subjected to the same influences as the liver, we may be allowed to presume that moral affections exercise a strong action upon its secretory function.

The secretion of mucus is so greatly influenced by violent passions, that this humour is suppressed, thickened, or altered, during their paroxysms; and these changes are the greater, the nearer the secreting membrane approaches to an inflammatory state. The pus of inflamed surfaces, although an extraordinary secretion, seldom escapes considerable alterations in moral affections of any intensity. This fact is so well known to those who practise surgery, that I deem it useless to dwell upon it here.

The influences exercised by the passions upon the locomotive muscular apparatus are the more active, as all the muscles that compose it are submitted to the orders of the will. They are such, that the least affective movement is manifested on the exterior, at least by the modification of the contractility of the muscles of the face. But if the passion declares itself, other muscles, as we have already seen, participate in it; and it is always to an intermittent or continued convulsion that this modification tends: hence arise violent agitations, and even tetanus, which may prove fatal. But it is necessary to observe, that, in these cases, the encephalo-spinal apparatus undergoes a stimulation, which may give rise to all the disorders I have sketched when speaking of violent deaths produced by strong paroxysms of passion. When the results of the convulsions of which we now speak, are not carried to this extreme, they may still be such, that persons retain a convulsive mobility, manifested in consequence of the least stimulation; and it is thus that epilepsy and hysteria are frequently the results of anger, of terror, and of all those passions capable of strongly agitating the apparatus of external relation.

The visceral muscles are far from being protected from the influence of the passions. We have already seen with what energy they act upon the heart: their action upon the muscular layers of the digestive apparatus, bladder, and even upon the membranous tissues of the bronchiæ, and the pulmonary vesicles, are not less conspicuous; since we often observe after violent emotions, vomit-

ings, which in some instances become habitual,—the discharge of excrements,—sudden emission of urine, and a spasmodic constriction of the bronchia, which opposes itself to inspiration, and produces obstinate asthmas.

After nervous and hemorrhagic modifications produced by the passions, we meet with those of an inflammatory and sub-inflammatory nature. They may be observed in almost every region of the body in which the two former are apt to appear. Do we not see, in fact, the strong affections of the soul produce inflammation in the encephalon, in all the mucous membranes, and in the parenchyma of the viscera? Do we not observe, that the passions, which I may call *chronic*, determine scirrhus and indurations of every kind in those parts? Every one repeats, that the scirrhus of the pylorus may be the effect of long-continued grief; it is possible that in such cases the lymphatic affection is not the direct effect of the passion, but rather of the mucous inflammation which this has occasioned in the interior of the gastric organs. But how often has it not been seen, that moral affections suddenly determine herpetic complaints? Does not this prove that the exercise of thought may directly stimulate the white tissues and different secretory organs of the skin, in the same way that it stimulates the mucous follicles, and the largest and most important of the parenchymatous glands.

Such are the tissues upon which moral affections exercise an influence in the natural state. The areolar tissues, the serous and synovial membranes, may, in some cases, though very rarely, become affected with a sanguineous exhalation produced by violent passions; but moral affections only cause in them a sensation of pain, when some previous inflammation has exalted their vital properties,—has put them on a level with the other tissues, naturally more sensible; and has, in some manner, converted them into artificial senses. It is thus, I think, that we can explain how a fit of anger may become the exciting cause of a paroxysm of gout, of pleurisy, peritonitis, and arachnitis. In all these cases, the inflammatory predisposition exists in the ligamentous or serous tissues, and the moral affection is limited to determining its explosions. Every one knows that gout is often preceded by gastritis, attended with a plethoric state; in such cases the irritation of the stomach, exalted by the moral affection, is transmitted to a joint, the vital properties of which had been increased by cold, and gout is the con-

sequence. We may even conceive the production of a paroxysm of gout by the effect of a passion, without admitting a previous gastritis, when cold, a contusion, or any other cause has predisposed a joint to irritation; since the articular ligaments are in direct correspondence with the brain, by means of the nerves of the encephalic and spinal domain. At other times the inflammation has been developed in the brain, pulmonary parenchyma, or gastro-intestinal mucous membrane: a movement of anger or of terror supervenes; it communicates a new impetus to the inflammation, which traverses the whole thickness of the organ, and extends with extreme rapidity to the serous membrane. From this we perceive the great necessity of managing carefully the minds of persons attacked with an acute inflammation, and why nostalgics and timid persons so often and so suddenly fall victims to febrile diseases, in spite of the most multiplied and best directed efforts of the art.

The cartilages, fibro-cartilages, periosteum, and bones, are the only tissues upon which the mind exercises no influence in a natural state. Long-continued inflammations are necessary to develope sensibility in them, and put them in relation with the encephalic apparatus; but when they have arrived at this state, they are placed under the influence of the passions; as may be shown by cases of exostosis, osteo-sarcoma, and spina-ventosa, accompanied with deep and persisting pains, which violent moral commotions rarely fail to exasperate, at least in subjects of a nervous constitution.

Section III.—*Each Passion exercises a Morbid Influence over certain Organs.*

Having now pointed out, in a general manner, the influence of the moral on the physical system, it is proper to assign to each passion the organ over which it exercises a peculiar influence. After all that has just been said, this labour will be easy, and will not fatigue the attention of our readers.

All the passions founded on pleasure, possessing the property of precipitating the organic movements, and of propelling the fluids towards the surface, are commonly favourable to health. Yet they are not always free from inconveniences; for, in this violent state, sensibility is so greatly exalted, that it may be completely exhausted, and life annihilated by its excess. I have already said, that in such cases it appears to me, that the encephalon is not always ex-

empt from a truly sanguineous congestion. The predominance of cerebral irritation in excesses of joy, is further shown by the circumstance, that insanity is frequently the result of them. All passions founded on pleasure, may produce this disease; and experience proves, that it is often as difficult of cure as that which depends on the melancholy and painful passions.

Certain pleasures which are too keen, as those for example that accompany the venereal orgasm, have moreover, the inconvenience of stimulating the heart with so much energy, that it becomes aneurismal, or undergoes a rupture which necessarily and suddenly proves fatal. The extraordinary afflux of blood towards the tissue of the lungs, may also, in these cases, give rise to hæmorrhages and inflammations. It is thus, that excessive enjoyments always hasten the progress of phthisis pulmonalis in young persons predisposed to chronic pneumonia; it is also by a similar influence, exercised over the encephalon, that onanism determines and keeps up epileptic fits. Much has been said of the debility which always results from excesses of this nature, and not sufficient of the consequences of the sanguineous congestions they always occasion in the principal viscera; yet this is the most important point; for weakness is easily corrected in youth; whilst visceral irritations, which have not been combated at their onset, constitute so many germs of languor and destruction, necessarily increasing under the influence of stimuli and tonics, too often and abundantly prescribed to persons who have made a long and immoderate use of venereal pleasures. Nevertheless debility ought not always to be neglected, and this is the proper place for tracing its signs, in order to compare them with those of the visceral irritation. Persons who abandon themselves to these kinds of excesses, finally end by being affected with dulness of their eyes, which are surrounded with a livid circle; their sight becomes weak, their senses blunted, and their muscles so feeble as to be unfit for the slightest exercise. The influence of the emission of semen upon muscular strength is so considerable, that I knew at college a young man, (very robust, and fond of parading his muscular strength,) who raised fifty pounds less than usual on the days he abandoned himself to a single act of masturbation. Hence, the ancient Greeks took the utmost care in forbidding all kinds of amorous enjoyments to the athletæ whom they raised in their gymnastic establishments. Venereal excesses have, among other inconveniences, that of affecting, in young subjects, the intel-

lectual faculties; their attention is diminished, their memory weakened, and the habit of exercising their thoughts solely on the series of ideas relating to their ruling passion, renders them unfit for study, and is singularly injurious to their education. The reader may consult, on this subject, Tissot's work on Onanism. Although he has attributed to the vice he attempted to deprecate, a number of evils which did not depend upon it,—which even, sometimes, were rather the effects of the tonics that were lavished on those unfortunate persons, whose deplorable situation he has described; yet he has treated of the debasement of the intellectual faculties which too often afflicts them, in so superior a manner, that it would be rashness to undertake to go over the same ground.

The epigastrium becomes painful in libertines; the sensation of languor which they refer to it, is at first removed by stimuli; hence, they seldom fail to carry these to excess, and thus bring on gastrites, which are necessarily exasperated by the persevering use of tonics.

The enjoyments of comparison have all the inconveniences of the passions founded on pleasure. In many instances insanity is occasioned by the inflation of pride; and this word itself—inflation—truly portrays the acceleration of the course of the blood, its afflux towards the external tissues, which seem to increase the volume of the body, and the great turgescence which takes place in the encephalon and in the erectile tissues of the face and neck. Still, it can only be by its extreme exaltation that the pleasure of gratified pride can become dangerous; in most cases, on the contrary, this passion is favourable to the exercise of the functions, and to the developement of every kind of strength.

There are numerous tranquil intellectual enjoyments, which do not derange the functions in a direct manner,—but, on the contrary, favour them, and in this way concur to the maintenance of health. Such are the pleasures of study;—those procured by the cultivation of the arts;—those which result to the man of probity and delicacy from the fulfilment of his duties;—those which an industrious man obtains from his labour, when fortune crowns his efforts;—those of friendship;—of the love of parents and relatives;—in a word, all the pleasures which mildly excite the nervous system without developing any passion. There results from these a continual feeling of well-being, a moderate joy, which maintains the regular influence

of the nervous system or the harmonic distribution of the vital powers. It is true, that one may sin by carrying any kind of enjoyment to excess; but the enjoyment then ceases to be included in the series of which I am now speaking, and its bad results must be assimilated to those which accompany the abuse of the intellectual faculties, and of the passions above mentioned, or those of which it remains for me to treat, under the head of painful passions.

The passions founded on pain having been distinguished into, first, *painful passions without reaction*,—secondly, *painful passions with reaction*, I must follow this order, with a view of pointing out their particular effects.

Section IV.—*Of Painful Passions without Reaction.*

Melancholy and terror, which constitute this series, have for their effect the production of a painful internal sensation, in the contemplation of which consciousness is absorbed, whilst it forgets, as it were, the locomotive apparatus and the external sensitive expansions, now in a state of diminished activity. The skin becomes cold, perspiration diminishes, the muscles languish, and lose, when these passions continue long, a part of their contractility. Under these circumstances, man lives, in some measure, within himself. This sensation, which thus concentrates the cerebral action residing in the viscera, supposes that the organic activity of the nerves which are distributed to them, is permanently increased. In fact, the heart is constricted, as melancholic persons say, since it contracts in too persisting a manner, and does not allow itself to be sufficiently dilated by the blood which is presented to its cavities; hence, the pulse is small, sometimes accelerated, but never full, unless a reaction supervenes. Circulation is then imperfectly performed; from which results a feeling of restraint, a great uneasiness in the lungs, giving rise to sighing, which is determined by instinct, solicited by the want of respiration. This uneasiness must naturally add to that depending on the melancholy ideas which occupy our attention. As the muscular coats of the digestive canal participate in the constriction of the heart, and in the effects of the stagnation of the blood, the uneasiness is likewise referred to the epigastrium and to the liver, but rarely to the small intestines; because, in the natural state, they are but slightly sensible; as to

the large intestine, no sensation is referred to it. The stomach seems to become cool, as, on the contrary, it appears to become heated in joy.

These phenomena, which are at first nervous, are soon accompanied with vascular lesions;—melancholy feelings, too intensely contemplated, and too much nourished by the mind, soon occasion a congestion in the viscera in which they are seated, or rather to which they are referred,—these parts become overheated and pass into a state of vital erection already morbid; when this occurs, the uneasiness increases,—the over-stimulated viscera react, through the medium of the brain, on the apparatus of locomotion. The individual affected with melancholy, after remaining for some time in a state of immobility, is instinctively agitated, and experiences a movement of hatred either against the sensation or its cause; under these circumstances anger is on the point of being developed. But if the ideas which have given birth to the melancholy passion, renew incessantly the movements of concentration, anger is repressed, and melancholy without reaction becomes predominant and habitual.

Let us now suppose, that this condition persists a long time, as happens in weak and timid individuals: there will necessarily result in the viscera, engorgements, which will be inflammatory in sanguineous constitutions, and lymphatic or sub-inflammatory in those of a reverse temperament. Nervous mobility will always be established in the suffering organs: but will be carried to its greatest height if the temperament be of that species denominated *nervous*. In individuals of a mixed temperament, there will be at the same time inflammation, sub-inflammation, and neurosis;—all of which will terminate in the disorganization of the principal viscera of the economy. It is in this way, that we daily see developed and kept up, chronic hypochondriacal gastritis, scirrhus, hepatitis, fatty and tuberculous liver, hypertrophy and aneurism of the heart, and asthma; and for the brain, mania, dementia, epilepsy, and apoplexy. Those women whose generative apparatus is very nervous, will experience, under the influence of similar causes, the symptoms of hysteria: this affection, however, will not exist alone, but will be combined with irritation of the digestive organs; and woe to the physician who does not suspect the existence of this complication.

All varieties of melancholy may give rise to the effects we have pointed out; but they produce them more frequently in young

timid persons of both sexes, who have been brought up in the rules of decorum and accustomed to dissimulation; whether the passion consists in thwarted love, of which such individuals endeavour to conceal the least symptom, or whether it depends upon a disguised jealousy, or the desire of revisiting their native country and the persons whose society constituted the charm of their infancy. Such are, indeed, the most usual causes of that melancholy without reaction, which we are now examining. It is plain that many other causes may exist, such, for example, as the loss of a beloved friend whom it is impossible to replace, &c.: but it would be useless to enumerate them here.

Fear does not always produce effects analogous to the preceding, because it is rarely of as long continuance as melancholy, and because it occasions, in most instances, a nervous and vascular reaction. The individual affected with fear may, as we have already seen, like the one troubled with sadness, perish in the first period of the impression; but if this does not occur, he becomes agitated, and developes muscular movements. These may lead to inflammations; but they often terminate in convulsive mobility, and particularly in epilepsy.

We have referred to the melancholy passions without reaction, that horribly painful state denominated *humiliation*, and which depends on wounded self-love. He who experiences in a violent degree this moral pain, feels as if prostrated at the moment he receives the affront. Like those affected with melancholy or fear, he remains in a state of immobility, and may even perish at this cruel moment; for there is no sensation which suspends so powerfully the action of the heart and respiratory organs. If he do not perish, existence becomes odious, because he lives only to suffer;—there is not a viscus which does not reflect to the centre painful sensations; whilst *self* does not react with the greatest degree of energy. I think I have observed, that under such circumstances the heart suffers considerably, becomes enlarged, and receives an impetus which leads it to hypertrophy, and to aneurism. The brain is sometimes so powerfully irritated, as to give rise to mental alienation. The stomach is perhaps less seriously affected; yet I have seen some very obstinate cases of gastritis result from this cause; but I should be more disposed to attribute them to the secondary melancholy than to the moment of *humiliation;* for melancholy is always an inevitable result of severely wounded self-love.

The confusion of ideas, and the kind of prostration, experienced in shame, are rarely attended with serious results; because self-love is not always greatly humiliated, and because the secondary melancholy does not constantly follow. They nevertheless give rise to cephalalgia and palpitation, which may be attended with very alarming effects, by producing sick headaches, and a convulsive habit of the heart.

Whenever painful passions excite the flow of tears, this secretion dissipates the state of anguish which precedes and occasions it, and constitutes a true crisis, which must necessarily be compared to those occurring in a number of acute diseases; but a sort of reaction then exists, which prevents us from assimilating these passions completely to the preceding ones. Thus, the pain of the epigastric centre changes to a sensation of rising, directed towards the pharynx, and tends to produce, and in fact produces, a strong agitation in the respiratory muscles;—at the same time that the heart precipitates its contractions, and the blood is propelled with great violence towards the head. It follows from this, therefore, that the irritation is not concentrated in the viscera,—the movements of the muscles of the arm, and even those of the other muscles, evincing its diffusion; but it is a fact worthy of remark, that this visceral uneasiness is completely removed only by means of the secretion of tears. The results of this uneasiness, and of the muscular contractions which are combined with it, are hæmorrhages, inflammations, and convulsions, which may become habitual; hence persons who cannot weep suffer more and longer than those who shed tears. This advantage, however, is counterbalanced by some inconveniences; for the flow of tears, when too frequently repeated, gives rise to an engorgement of the brain, and to ophthalmia, and alters in time the organization of the eyes. Although it cannot be denied that tears relieve temporarily, yet it must also be confessed, that in some individuals this momentary crisis does not prevent the return of the pain that has caused it, and the tears are shed during a long space of time. Under these circumstances, the inconveniences of concentrated grief are united to those of the passion which is vented, and an unhappy sufferer of this kind finally falls into a most deplorable state.

On the other hand, it would be dangerous to rely on the testimony of those who never shed tears, and yet maintain, that they are more sensible and suffer more than those who weep; this asser-

tion is, in very many instances, a mere pretext for concealing their absolute defect of sensibility. But the physiological physician, who knows how to interrogate the functions, will never be the dupe of this excuse. A sufficient number of sympathies are outwardly observable to enable him to judge of the sufferings of the concealed organs. He will make use of them to form an idea of the condition of these pretended sufferers, and will not confound affected with true sensibility.

Section V.—*Of Painful Passions with Reaction.*

I have already said that the *painful passions with reaction* are those which give rise to anger and flight. Flight soon causes a movement of expansion, which at first corrects the baneful effect of terror; when moderate, therefore, it cannot fail to be attended with advantageous effects; but when excessive, it has all the inconveniences of muscular exercise carried too far. As I shall speak on this subject when treating of locomotion, I think it superfluous to dwell upon it now.

The movements of anger have already been examined when treating of this passion; it only remains, therefore, to discover their pathological results. The sensation which gives the first signal of the explosion of anger, is an acute pain referred to the epigastric centre; indeed, so certainly does it exist in this region, that vomiting of blood,—excessive secretion of bile,—and sudden absorption of the latter producing jaundice a few moments after, and violent gastritis, are often its consequences. That these phenomena are produced by the direct influence of the brain acting through the agency of the nerves, does not in the least change the state of the question; for it is not the less certain, that the epigastric irritation forms a part of the passion denominated *anger*, and that the principal seat of the former is in the stomach and its appendages. Besides, experience teaches us, that, when primitive, it directs the centre of perception towards the ideas of anger. This passion, when physiologically considered, is primarily a simultaneous irritation of the brain and epigastric centre; hence, the vital action of the brain is often changed, in the most violent paroxysms of anger, into hæmorrhage or inflammation. From this arise attacks of palsy, apoplexy, and phrensy, which often resist the best directed efforts of the art.

F. Hoffman understood this truth, as may be learned from his dissertation *De medecinâ emeticâ et purgante, post iram, veneno.* This physician, one of the fathers of solidism, felt how dangerous the theories of the humoralists might be in those gastric and cerebral affections, which are so often the result of anger. He relates many examples of such maladies, and advises physicians not to allow themselves to be imposed upon, by the bilious turgescence which is manifested in them. For the removal of this latter state, he merely employed antiphlogistics—paying regard, as he did, only to the irritation producing it. Why has he not made a more extended application of this happy idea? And why have not his successors improved upon it? It is because the science of pathology was, in great measure, filled with chimerical beings, which, under the shield of high authorities, were continually increasing in number. Let us continue to exert our efforts in overthrowing all these idols.

The association of the heart with the head and stomach, forces it to participate in the irritation which these experience in anger; but it will not now be constricted, as in the painful passions, without reaction; or, if it be so, the constriction will continue but for a short space of time. The heart will soon become turgescent, blood will be attracted with force in its tissue, and it will, perhaps, be liable to hypertrophy. If it be already debilitated and enlarged, in consequence of an aneurismal state, some of its cavities may even be ruptured. The aorta will not be free from all danger, and the lungs also, becoming suddenly engorged, may, perhaps, be ruptured or become inflamed. I have seen hemoptysis and violent pneumonia result solely from this cause. The muscles, agitated by a too precipitate innervation, may remain in a tetanic state, or preserve, ever after, a convulsive and distressing mobility.

Such are the consequences of anger considered as an acute passion, whatever may have been the painful one against which it has served as a reaction. If we examine it in its chronic state, we find that its effects are less terrible, though still very alarming. The habit of impatience keeps up gastritis, and annuls all the effects of remedies and of regimen,—it prepares the way, and determines attacks of, apoplexy,—it occasions the return of epileptic, hysterical, and gouty paroxysms,—it brings on with redoubled violence habitual convulsions and tremblings, and excites on the skin the most rapid inflammatory congestions. An elderly man was seized

with a violent fit of anger, in consequence of a visit from some foreign soldiers in 1815. He was suddenly affected with a large erysipelas on the right lumbar region, which became gangrenous, and occasioned an extensive slough. It must also be borne in mind, that all the violent passions have the property of bringing on suddenly herpetic diseases, more or less inflammatory, the cure of which is sometimes very difficult to accomplish.

Anger is one of those passions, that act with greatest energy on the various seats of acute or chronic inflammation ; hence, surgeons dread its influence in all sorts of wounds. If there exist a painful part, either internal or external, or if this part be merely more irritable than the rest of the system, anger will excite in it an increase of sensibility. In some individuals, it will occasion the return of sick headache,—in others it will re-excite the sensibility of joints that have suffered from rheumatism and gout, that is to say, that have been inflamed; in a word, this passion occasions, in the most uniform and general manner, the exaltation of contractility and sensibility, which demonstrates very evidently its widely extended perturbating property.

Those who endeavour to limit every thing to the brain, make use of these facts in order to show that anger does not act on the epigastrium in a manner different from that in which it acts on the rest of the tissues; they have forgotten, that without the sensation felt in the epigastrium, anger could not exist; and that the ideas capable of exciting it cannot succeed in doing so by merely re-exciting the sensibility of another part,—for example, of a gouty knee. In order that these exaltations of sensibility should occasion fits of anger, it is always necessary that they should react on the epigastric centre; whilst, on the other hand, pain in this part cannot exist without giving rise to some shades of this passion. Must we once more tell them, that individuals who had never been subject to anger, have been easily excited to it while labouring under an attack of gastritis, and have got rid of it in consequence of being cured of this inflammation ? If I repeat this truth, it is because I have, within a few days, met with a new proof of it. Besides, as it is indispensable to prove the influence of the viscera on the passions, for the purpose of facilitating the knowledge of physiological pathology, I do not think I have enlarged too much on this subject.

What I have hitherto said, might perhaps be sufficient to point out the great influence which the passions exercise on health; ne-

vertheless, I think it useful, after studying those that are painful and agreeable, to direct our attention to such as are of a mixed character. We have seen, that pleasure produces expansion, and pain concentration; with these facts before us, nothing will be more easy than to comprehend the effects of the mixed passions; since we shall discover them to consist of these two opposite movements. It would be wrong, however, to consider them as simultaneous: they cannot be so, and must therefore, of necessity, occur alternately.

Let us glance over the passions in which this double modification is observable. Grief, resulting from an obstacle encountered in our first wants, is rarely simple,—at least in the adult; but almost always combined with the agreeable recollection of the pleasures resulting from the gratification of these wants, and from the enjoyments of anticipation, when we imagine ourselves at a future period, and desire to obtain the means of appeasing them. Are not unfortunate beings who suffer the torments of hunger,—who long after rest,—who seek the means of relieving their sufferings, or implore the necessary succour to escape from an imminent peril, placed under similar circumstances? The passions under which they labour are consequently mixed, and the most cruel concentration of pain is counterbalanced by the delightful expansion of pleasure.

Jealousy, when produced by sexual love, supposes always the coexistence of pleasure and pain; when produced by other causes it is still of a similar nature; for why are we afflicted by the privation of a pleasure, if not because we have already enjoyed it? and when we are deprived of it by a rival, we are only afflicted because the recollection of that pleasure constitutes, itself, an agreeable sensation. Hence, we enjoy by the exercise of memory, by which the past pleasure is recalled to the mind; and we suffer, the succeeding moment, from the idea that we are deprived of this pleasure.

The modifications we experience when jealousy is nourished by the fear of being deprived of our present enjoyments, are of a similar nature; but in these cases the pain, instead of being produced by a remembrance, is excited by the anticipation of this privation; by this we are made to foresee the possibility of being deprived of the pleasures we enjoy, and this fear of loss is equivalent, as respects the modification of our organs, to the loss itself; since we in fact suffer when we foresee the possibility of suffering. Consequently, whether jealousy depends on wounded self-love or arises from an obstacle we meet to the gratification of another instinctive

want,—or from wounded pride;—whether it has reference to the past, present, or future, it does not cease to be a mixed passion, compounded of alternations of pleasure and pain. We suffer from the idea of pleasures of which we have been, are, or will be deprived; as well as from the idea that another has enjoyed, enjoys, or will enjoy them;—in the same way that we are gratified by the recollection of pleasures of which we have been, are, or will be deprived. In a physiological point of view, emulation, ambition, and envy, are of the same nature.

In regrets, uneasiness, fear, and despair, occurring without any motive for jealousy or envy, the physiological modifications are similar to those we have been examining; since we invariably discover in them the comparison of pleasure with pain; with this difference, however, that we do not observe in them the particular kind of pain depending on the idea that another individual has been, is, or will be in possession of enjoyments to which we are entitled, it is, however, but a minor degree of pain that is experienced.

Avarice is also a mixed passion: but it differs in this from all others, that the pleasure depending on the gratification of the first wants is in perspective; that is to say, that the avaricious man's enjoyment is only the hope of enjoyment. We discover in it, however, an intellectual pleasure, depending on the actual contemplation of the means of enjoyment in our possession; such, for example, as that experienced by the avaricious man pleased with the view of his treasures. Those who are free from this ridiculous passion might, perhaps, imagine that this pleasure is very limited; yet, it must be very considerable; since the miser sacrifices all others to it: and this is a further proof of the unlimited power of the mind in modifying the acts required for the gratification of our first wants. Avarice is, therefore, a purely intellectual passion: we have directed attention to its pleasures; the pains, by which it is rendered of a mixed character, are the results of prescience, which exaggerates, in the mind of misers, the bitterness of privations that might result from the loss of their means of enjoyment.

In compassion and pity, we again discern the sufferings excited by the fear of pain and destruction; and of which we make the application to ourselves by observing them in others. We likewise discover the pleasure depending on gratified self-love, when, always impelled by the same application, we perform acts of beneficence. If anger intervene, as a means of reaction, in the pains of

these different passions, their mixed character becomes still more striking; since the pain, peculiar to anger, establishes a stronger contrast with the pleasure of those passions.

I say nothing of fanaticism; for it is evident that the elements of which it is composed are reducible to those passions I have just enumerated.

Whenever man is agitated with the impassioned movements which I have sketched, his frame undergoes, during the moments of pleasure, a general expansion, which is suddenly replaced by concentration, and *vice versa*. From this results, in a very short time, a vicious state of mobility, not only in the action of the nervous, but also in that of the vascular system. The least inconvenience resulting from this state, is the loss of equilibrium manifested by nervous phenomena,—by fluxions, inflammations, evacuations of all sorts, which supervene without any evident cause, and disappear in the same manner. Affections, in appearance the most trifling, occasion, with an astonishing facility, all these derangements. Moreover, every individual who has experienced for a length of time the alternation of the mixed passions, loses the power of resisting atmospherical vicissitudes; so that he is constantly a prey to diseases produced by these causes.

If we endeavour to remedy all these evils by the powers of the art, we almost always fail in the attempt. Medicines invariably act either to an inordinate extent, or give rise to effects totally unlooked for;—the nervous apparatus of the viscera, are almost always too sensitive; because the passions have excited their vital properties to a degree far beyond that suitable to health;—the most trifling irritations of their tissues, especially of the mucous membranes, and of the brain, occasion pains and extraordinary movements, which in other individuals are produced only by the most extensive alterations. It is this that constitutes hypochondriasis. It is true that this disease arises from many other causes, but the one we have just noticed is undoubtedly the most powerful. Hence, all individuals who have long been tormented by the mixed passions, become hypochondriacal or neuropathic. This exaggerated nervous susceptibility occasions a great deal of obscurity in the diagnosis of diseases, so that, amid the complaints, terrors, and sufferings of these unfortunate beings, it is very difficult to ascertain the degree of alteration existing in their principal organs. It is on this account that many physicians regard them as visionaries,—neglect

them, or prescribe remedies which the too great sensibility of their viscera renders them incapable of supporting. If, however, we bear in mind the evident alterations in the secretions,—the flatulence,—the evacuations, and the visible congestions by which such individuals are affected, we shall find no difficulty in understanding, that real changes may take place in deeply situated tissues; and discover in them a sufficient cause for the painful sensations of which these persons constantly complain: but, unfortunately, the sympathies which ought to point out the concealed alterations, do not correspond to the degree of these latter, and too often disorganizations are effected in the viscera, before they are even suspected to have commenced.

I have not spoken of the more violent and perfectly characterized diseases produced by the inverse alternations of the mixed passions; but they are necessarily analogous to those which I have pointed out, in examining the effects of the highest degree of the simple passions.

Such are the innumerable evils that may and do daily result from the abuse of the intellectual faculties and of the passions. It is not simply by the cultivation of the intellect, that they can be prevented; but particularly by the study of philosophy. Philosophy consists in the study of wisdom, and wisdom implies a knowledge and love of truth. It is necessary to commence early in seeking for and discovering it; for it is from it alone that we derive the true and only intellectual enjoyments;—every thing else is idle fancy, error, or vanity. I do not allude to that scholastic philosophy for which forms are every thing, and which is made up of pure ontology. The desire of discovering truth is natural to all men; I even go further and assert, that it is a want,—one, too, which constitutes our intellectual faculties; for this want of observing all surrounding objects and comparing them with ourselves, this same want which I have taken pains to point out as the attribute of our species, does not consist in a vague curiosity, without any positive object; so far from this, it can only consist in the love of truth,—of that sublime and sacred love, of which it is impossible to discover the least traces in the numerous animals, which, together with the human family, serve to people this vast universe.

CHAPTER XI.

OF THE MUSCULAR APPARATUS OF RELATION, AND OF ITS DEPENDENCIES.

The muscular apparatus of relation is naturally divided into, 1. the *cephalic muscles*, destined to progression,—to the displacement of the whole body or of some of its appendages; 2. the *cephalo-splanchnic muscles*. The first are exclusively under the control of the will. The second are primarily obedient to instinct and secondarily to the will. The accessaries of this apparatus are the bones and their uniting substances; the whole of which constitutes the skeleton. Let us first examine in a general manner the entire apparatus.

The muscles of relation are composed of fibrin,—of a laminated tissue, gelatinous in its nature, which is placed between the muscular masses and between the fasciculi of which they are composed,—of aponeuroses and tendons, likewise of a gelatinous nature. The muscles are fixed upon the skeleton, which is made up of bones,—gelatinous masses combined with phosphate of lime, from which they derive their solidity;—of cartilages and fibro-cartilages, which differ from bones only in containing a less quantity of calcareous phosphate,*—of ligaments, the gelatin of which contains a minor proportion of salts,—and of the articular capsules, which contain none in a healthy state. Another coat of gelatin, spread over the bones and cartilages, serves as a uniting medium between them and the soft parts; it is denominated *periosteum* or *perichondrium*, according as it covers the bones or cartilages; and has received from Bichat the title of fibrous membrane. This vast apparatus, which by itself constitutes the greater portion of the volume of the body, is plentifully supplied with arterial, venous, and lymphatic vessels, and with nerves.

The fibrin of the muscles is arranged in lines, which form fasciculi of greater or less size, and the direction of which determines

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* This though the common belief, is not strictly accurate; the essential difference consists in the large proportion of albumen, it being 44.5 per cent. to 0.5 of phosphate of lime, and 55.0 of water, in cartilage.—TRANS.

the nature of the movements to be executed. The laminated and cellular tissue serves to separate the muscles and their fasciculi;—to fill up the space existing between them;—to preserve their suppleness and facilitate their movements, and to contain the vessels and nerves with which the muscular fibrin is supplied. It is in this tissue that the blood-vessels are divided and subdivided, before penetrating into the fibrin; hence it may be regarded as serving to nourish the muscles, and preserving them in a degree of temperature favourable to the performance of their functions. The animal oil, denominated *fat*, which is exhaled in great abundance in this tissue, wonderfully contributes in aiding these functions.

The aponeuroses serve to separate and contain the muscles, and to prevent their displacement; and are further useful by affording them points of insertion. The tendons are restricted to this latter use; but in several parts of the body, the muscular fibres are attached to the bones without their intermediate agency.

The bones constitute the basis and points of support of all the soft parts,—sometimes they contain or suspend them, whilst at others they are imbedded in them. The muscles are always attached to the bones, which serve as levers for the various movements necessary to be performed. It is for this reason, that the osseous apparatus is composed of various pieces, more or less moveable on each other. Sometimes the bones are moved alone, and constitute so many levers; in other cases several bones are solidly fixed together, so that the whole constitutes but one lever; as for example, the head. The points of contiguity of bones are denominated *joints* or *articulations*. There are several kinds of them, according as they are without motion, or as their movement is rotatory, at right angles, or more or less oblique. Bones differ in respect to form and consistence; some are hard, cylindrical, and hollowed in their whole extent, by a canal containing a very fine cellular tissue filled with an animal oil denominated marrow; others are flat,—others, finally, are large and short, and vary in shape, according as they are destined to different uses. These two latter kinds have no central canal, but are composed of laminæ, more or less compact, which form their external surface; and of an areolar osseous tissue, placed between these laminæ, and filling up the intervening spaces. This tissue is lined by a membrane which secretes an oily fluid, analogous to that contained in the cavities of

the hollow and cylindrical bones. All the bones are pierced on their surface with holes, through which the vessels and nerves, serving for their nourishment, penetrate.

The bony pieces, (the cylindrical,) destined to the movements of the middle of the limbs, are enlarged as they approach each other, and form surfaces, in which are seen eminences and cavities, corresponding to each other in the most admirable manner; these enlargements are denominated the *heads of the bones.* The medullary cavity does not extend as far as the head, which is composed only of an areolar and spongy tissue, covered over with a more solid crust, like the flat and short bones, and which, like them, contains in its interstices a medullary substance. From this arrangement, they acquire, by enlarging their points of contact, a greater degree of solidity, without increasing their weight. The heads of the bones are covered with cartilages, by which their contact is rendered much easier,—and these cartilages, which are denominated *articular*, are themselves lined with membranes named synovial, a kind of bags without openings, which pass from one bone to the other contiguous to it,—lining, at the same time, the internal surface of the articular ligaments, and giving them the same degree of suppleness as they do to the cartilages.

The use of the ligaments is to strengthen the joints, and, in conjunction with the forms of the eminences and cavities found on the heads of both bones, to regulate the extent of the movements. These ligaments are arranged in the form of bands on the sides of the joints which move at right angles, and in shape of sacs around those the movements of which are rotatory. Some are arranged obliquely, and allow a certain rotation,—some limit flexion,—others extension ; they are, in consequence, endowed with a very considerable resisting power. It is always remarked, that their gelatinous fibres cross each other in a greater or less degree, so that their extension cannot take place in any direction. The earthy salts with which they are combined, contribute to afford them the degree of resistance of which they are in need.

There are some bones, the mobility of which does not depend on this kind of articulation; these are united by a substance semi-fibrous and semi-cartilaginous, which allows of a sufficient degree of the movements of twisting, compression, and distention, for the performance of the functions of the organs. Such, for example, is the vertebral column, each fibro-cartilage of which contributes in a

very small degree to the movement of the whole. These bones, like the former, are strengthened by ligamentous bands, which, however, are not as solid as those of the joints of the limbs; because they must also contribute to the different movements of the column. Numerous muscles concur with the ligaments to strengthen the joints.

The immoveable articulations are united by uninterrupted and almost inflexible cartilages; their use is to lessen the force of percussion, and to prevent the occurrence of fractures; they are found in the head, pelvis, &c.

In some parts of the body, and particularly in mammiferous animals, we find enormous ligaments, the use of which is to suspend certain bones, or a cluster of bones; and to relieve the burden of the muscles, which, in other species, are alone charged with this office: such is the cervical ligament.

The muscular apparatus, and its appendages, are put in relation with the brain and the various viscera, by means of the vessels and nerves (K) in virtue of which they participate in the common life, and are associated, in their movements, with the wants of instinct and of *self*. As soon as this double communication is interrupted, the muscles lose the power of motion, become smaller in size, and die together with all their dependencies; but if their nervous communication alone be intercepted, we only notice the loss of motion and of sensibility. Under such circumstances, the extremities retain life through the agency of the blood-vessels; but as they no longer participate in the stimulations of the rest of the body, and, having no movements to perform, cease to attract a larger quantity of blood, they enjoy only a very monotonous contractility which gradually diminishes; and the flow of blood, by which they are nourished, also diminishing in an insensible manner, they are finally atrophied together with all the soft tissues annexed to them. The bones alone, in consequence of the earthy phosphate they contain, are not diminished in size; but it appears to me probable, that their elementary gelatin must finally be found in a smaller quantity than in the healthy state.*

What proves that the wasting of the muscles, in paralysis, depends solely on want of exercise, is the atrophy under which they

* All these remarks apply only to the cephalic muscles, which are exclusively under the control of the will.

labour, when kept in a state of immobility by causes different from that disease,—as for example, fractures, painful rheumatisms, &c. The atrophy which supervenes in the muscles of the thorax, in consequence of a chronic inflammation of the lungs, by which they are prevented from moving, may be offered as a further proof of the correctness of my assertion; for these muscles do not cease to correspond with the brain and viscera. In fact, their immobility is only the effect of pain or of the provision of instinct, which prevents them from aggravating, by their movements, the irritation of the lungs. At the same time, they are diminished in size, and their corresponding ribs become more brittle; from which we derive an additional proof, that the want of action of the motific apparatus prevents the nutrition of the parts entering into its composition.

The preceding remarks were indispensably necessary, in order to form a correct idea of the physiology of the apparatus of motion.

The muscles, being endowed with contractility, since this depends more peculiarly on that form of animal matter denominated fibrin, exercise it without interruption; they consequently always tend to shorten themselves, and in this way contribute, as I have already said, to strengthen the joints, even when the limbs are in a state of complete repose. This tendency in the muscles to shortening, may be proved by dividing them; it cannot, therefore, be denied to exist, and it would be ridiculous to regard it as a different property from that manifested under the influence of stimuli. This continual action in the muscular apparatus, contributes to the firmness of the body,—to the maintenance of the organs in their respective positions, and to the attitude. This same action diminishing after death, the cadaverous aspect is manifested, and that too so much the more evidently, as the contractility of the fibrin is diminished.

The stimuli capable of exalting the contractility of the muscles, and causing them to execute movements, are very numerous. Whenever a muscle is separated from a body which is full of vital energy, or, in other words, not fatigued by disease or by violent excitement of any kind, it is found to contract under the influence of a thousand agents, applied immediately to the fibrin which enters into its composition; such, for example, as the point of an instrument,—certain saline preparations,—the sudden action of caloric, and sometimes even simple commotion. But it is by means of nervous influence, that its contractility is most easily and power-

fully called into play; or, in other words, exalted to a degree surpassing that which is natural to it. In the dead body, it is sufficient to excite, by means of electricity or galvanism, a nerve distributed to muscles, in order instantly to cause their fibres to contract; but as the fibrin of these muscles no longer communicates with the sources of life, it soon loses its energy, and finally ceases to be excited by galvanic or electric shocks. The more this contractility is excited, the sooner it disappears; so that we may say, that it is exhausted by the exercise of its own action. When the muscles are attached to the living body, their contractility may, in like manner, be diminished by a too long and often repeated excitement; but they reacquire it by the exercise of life; a circumstance that cannot occur after death.

In the living and healthy economy, the influence which determines the movements of exaltation of the contractility natural to the muscles, always reaches them through the nerves; several physiologists have even thought, that these nerves excite them into action only by pouring into their fibres the electric principle or agent. I shall not stop to examine this question; as it is sufficient for my purpose, that it should be proved, that the nerves are the natural excitants of this sudden increase of the contractility of the fibrin,—producing what has been called *muscular contraction.*

When a muscle is in a state of contraction, blood is called in large quantity into its tissue, in virtue of that law we have alluded to above, and which orders, that whenever a fibre executes a movement of condensation, the fluids flow to it in order to produce *vital erections.* Every muscular contraction is, therefore, a vital erection.

If the blood arrives more promptly at the extremities when these are in a state of contraction, it also returns with greater rapidity towards the centre of the body, in order to make room for that portion of it which follows; and the quickness of this circulation is proportioned to the intensity and repetition of the movements of these parts. Hence, in a given time, the muscles, which act, expend a larger quantity of blood than those which are in a state of rest, and thus operate a true revulsion, at the expense of the other organs;—their nutrition is increased, and they are thereby augmented in size; and at the same time they acquire additional firmness. It may likewise be remarked, that the more the muscles act, the more they are disposed to action, unless this be carried to a

degree producing the exhaustion of contractility. It is thus, that strength and dexterity are the necessary results of exercise.

If we examine separately the two series of muscles we have alluded to, we shall discover between them differences which deserve to be noticed.

The cephalic muscles are only provided with nerves arising from the brain and spinal marrow. Such, for example, are the muscles of the extremities,—almost all those of the face and neck,—in a word, all excepting those of respiration. They present this remarkable feature, that in a state of health they only contract and relax through the influence of the will; they are therefore exclusively under the order of *self.* It is in consequence of thought that we see them take on extraordinary action, or simply reduced to that degree of contractility inseparable from the animal matter of which they are composed. But the cerebral influence by which they are called into play, may originate from various causes. As we have already said, in the greater number of cases, it is produced by the operation of thought in an individual enjoying good health, and influenced by purely moral motives; in such cases, the muscles execute movements, the order and co-ordination of which express the ideas of the individual, and indicate the object he has in view. Such are walking, running, jumping, performing on an instrument, and a thousand other movements more or less complicated, and having for their object to remove an external cause of pain, to escape from it, or to approach external agents capable of exciting pleasurable sensations. At other times the brain causes these muscles to act, in consequence of an imperfectly defined internal sensation; such, for example, are the movements executed during certain states of uneasiness, oppression, and anxiety. In such cases the individual is agitated without any well-defined object, though still under the influence of the will, since he may modify these movements, according as he abandons himself more or less to the contemplation of the sufferings he experiences, or obeys the motives he may have for concealing them. The same thing does not occur, however, in certain pathological states, in which the signs of consciousness have disappeared completely; such as the paroxysms of epilepsy, and the violent forms of hysteria, &c. In these cases the brain continues to determine movements in the extremities, &c. in consequence of an irritation transmitted to it from the viscera, or seated solely in its own tissue; but the absence of consciousness

does not allow us any longer to apply to this irritation the name of *sensation*.

It may thus be seen that the point of resemblance between all these cases is the irritation of the brain, which is transmitted along the nerves, and excites, in an extraordinary degree, the natural contractility of the muscles. The most important part of this subject to be remembered, is the necessity of the intervention of the brain, in the contraction of the muscles of which we are speaking; its existence is indeed most evident, since, in a state of epileptic or other similar convulsion, the movements in the limbs do not occur, whenever the nerves of these latter are tied or cut in such a manner as to destroy their communication with the brain.

Let us suppose, however, that, in an animal in which you have excited convulsions by stimulating the brain, a thigh, of which the nerve has been divided, remains free from them; you will have it in your power to cause this part to participate in the convulsions, by irritating the trunk of the nerve, or by galvanising it. By this experiment, you will acquire the certainty, that this part had not lost the aptitude to motion, and that, if it has remained calm when you irritated the brain or spinal marrow, it was because the irritation of these tissues was not transmitted to it. This fact, the correctness of which is notorious, proves most conclusively, that in those cases, in which an internal irritation, such for example as that produced by intestinal worms, or by a point of inflammation situated in an ovary, or at the neck of the uterus, excites convulsions in the extremities, it can only do it through the intervention of the brain. It likewise proves, that pain and pleasure are not a necessary condition to the production of these movements; and it is conclusively shown, that irritation is their only cause.

The following, therefore, may be laid down as so many positive facts; that the muscles I have called *cephalic*, are put in motion by a stimulation they receive, through the nerves, from the brain;—that in the greater number of instances, during the waking state, and when consciousness exists, the brain is induced to make them act, by the influence of the will;—that this will may be determined by external as well as internal sensations;—that when these are very acute, they may compel the brain to call the muscles into action, notwithstanding the express order of *self*, or, in other words, in despite of the will,—that when consciousness does not exist, as for example in certain comatose states, the causes of these sensa-

tions, that is to say, visceral irritations, may compel the brain to excite the contraction of the muscles; finally, that no viscus can call them into action, without the intervention of the brain, or at least of that part of it towards which all the nerves of sensation and motion converge.

Let us now examine the cephalo-splanchnic muscles. Besides the cerebral nerves and the spinal, which also arise from the brain, these muscles are supplied with filaments from the great sympathetic; in consequence of which arrangement they are at the disposal of the will or of the intellect, as well as at that of the viscera, and, consequently, of instinct. Nevertheless, a distinction must be drawn between these muscles and the first we have examined. The cephalo-splanchnic muscular apparatus, which comprehends the intercostals, the diaphragm, all the abdominal muscles, the orbicularis palpebrarum, and, according to some modern physiologists, the dilating muscles of the nostrils,—this apparatus, I say, is primarily subjected to the orders of instinct; yet, as the latter is not continually in need of them, they are left momentarily at the disposal of the will, which consequently makes use of them; but as soon as the viscera claim their aid, a sensation of uneasiness solicits the will to transfer these muscles to them. If the will resist, the uneasiness increases; if it persist in the refusal, the sensation to which I allude, and which is only a stimulation, overcomes the resistance, and the cephalo-splanchnic muscles obey the instinctive wants. It is not merely in reference to respiration, that this phenomenon is observable; all the viscera of the two great inferior cavities have equal claims on these muscles. Thus we see them concur, in spite of the will, to the wants of vomiting, defecation, ejection of the urine, and expulsion of the fœtus. Whenever the diaphragm descends, it is absolutely necessary that the abdominal muscles should relax, and *vice versa*. These muscles are even forced to conform themselves to the degree of fulness or vacuity of the stomach, intestines, bladder, and uterus. It is not in our power to compel them to contract to such a degree, as would oppose the enlargement of the abdomen when we eat; or to keep them in such a state of relaxation, as would prevent them from remaining in contact with the intestines, after the expulsion of the fæces, or the artificial evacuation of the serous fluid contained in the peritoneum. So, in like manner, it is not in our power to maintain the ribs in a state of elevation, when we execute the act of inspiration, unless we exer-

cise a strong pressure under the diaphragm, by contracting the abdominal muscles; and even to do this it is requisite, that the mass of the abdominal viscera should be sufficiently large to force up the diaphragm very high.

The cephalo-splanchnic or splanchno-cephalic muscles are, consequently, primarily at the disposal of the viscera for the gratification of the instinctive wants; but do they obey them without the intervention of the brain? This question has never been sufficiently investigated. I shall undertake to do so with all possible circumspection,—allowing an equal degree of importance to the reasons for and against it.

It is an undeniable fact, that respiration is a want perceived by the brain. The experiments of Legallois appear to me to prove this physiological point in the most satisfactory manner. Whenever he divided the medulla oblongata of the rabbit, above the insertion of the eighth pair of nerves, respiration continued;—it ceased, on the contrary, as soon as he destroyed this part, or when he divided the medulla below it. If these experiments are exact, the following is the manner in which we should reason. In destroying the point of insertion of the eighth pair, or in dividing its two branches, Legallois prevented the animal from feeling the want of respiration;(F) which, therefore, ceased to command the muscular contractions requisite for inspiration. In dividing the medulla oblongata below this point, he allowed the sensation of the want of respiration, which is transmitted to the brain by these nerves, to remain; but intercepted the communication of this centre of sensation with the nervous cords, by the aid of which the animal could determine the contraction of the inspiratory muscles; and respiration in like manner ceased. Let us now make the application of this fact to the living state. Whenever we refuse to gratify the want of respiration, the nerves of the eighth pair continue to transmit the sensation which manifests this want; but, by the power of the will, we prevent the transmission of the stimulation which should take place along the nervous cords that are distributed to the inspiratory muscles; finally, the sensation or stimulation of the want overcomes the power of will; the whole of which amounts to this, that the visceral sensation has the privilege of forcing volition. We have already seen, that in amphibious animals, the gratification of this want may be retarded much longer; but they are finally compelled to yield to it.

It remains now to prove, that the other sensations of which we have spoken, as the want of vomiting, that of defecation, &c. are executed by the same mechanism, and exercise an equal claim on the brain: and why should they not have this claim; since they make use of the same muscles for their gratification as the want of respiration? This induction appears to me to be extremely plausible; but still it is necessary to notice the objections that might be made to it.

For example, it might be said: "If the cerebral sensation is sufficient to associate the cephalo-splanchnic muscles with the viscera, for what reason has the Creator taken the precaution of establishing a communication between all the cerebral nerves which proceed, through the spinal canal, to the inspiratory muscles, and the great sympathetic? Does not the existence of such a communication tend to prove, that this nerve is in immediate want of the spinal marrow, in order to obey the viscera, independently of the brain—or, in other words, that the viscera require, in order to be served by their corresponding muscles, that their nerves should communicate with each bulging of the spinal marrow? Now, if these viscera can, by means of the great sympathetic, compel each point of the spinal marrow to contribute to their actions, the intervention of a cerebral sensation, or of a call upon the brain, ceases to be requisite."

In order to reply to this objection, we must bear in mind, that the branches of the great sympathetic, distributed to the viscera, do not arise from all the points in which the intercostal nerves are in communication with the ganglionic system; so that the direct relations, with the spinal marrow, only take place between the spinal nerves and those of the respiratory muscles. Thus, a few large branches are detached separately from the costo-ganglionic series, and serve to form, by multiplying themselves, at a distance from their origin, numerous plexuses, which are mingled with the blood-vessels, or are distributed to the viscera, where they are found in communication with the branches of the eighth pair. It must necessarily result, that these visceral cords, which preside over the life of the organs of the large cavities, do not make an appeal to the points of the spine, corresponding to these viscera; but rather to the brain, through the medium of the eighth pair which belongs to it.

But it may be repeated, what is the object of this regular relation

of the respiratory muscles with the spine? I believe, that it is to establish an association between these parts; but the experiment of Legallois which I have already cited, appears to me to demonstrate, that this association is not of such a nature as to exclude the necessary intervention of the brain in causing the cephalo-splanchnic muscles to act in conformity to the wants of the viscera. I am inclined to believe, that the branches of the tri-splanchnic which proceed to the intercostals, have less for their object to derive action directly from the spinal marrow, than to transmit to the viscera a part of the stimulation communicated from the brain to the respiratory muscles by the intercostal nerves, when it calls them into action, for the purpose of obeying the wants of these same viscera,—wants of which it has been informed by the eighth pair, which is always in direct communication with the extremities of the sympathetic branches it meets with in the viscera. I am perfectly aware, that this proposition may appear purely conjectural, but it will perhaps be supported by the explanations I propose entering into, when on the subject of the functions of the great sympathetic. In the mean time we may remark, that it is supported by the following reflection;—that the wants which determine the action of the cephalo-splanchnic muscles arising only in the viscera, and not in the muscles, it is impossible to admit, that the communications of the nerves of these latter with the spinal marrow, can serve to cause in it an afflux of nervous influence; consequently, the object of these communications can only be, to establish an association of action independent of this want; and I believe, that this association can only be that to which I have already alluded.

The second objection against the necessary intervention of the brain, might be drawn from the acephali. Thus we occasionally see some of these born, not only without brain, but also, in great measure, without spinal marrow. Now, these fœtuses have presented just proportions between the volume of their viscera, and that of the muscular parietes which contained them. Hence, it might be said, that the cerebral influence is not indispensably necessary, in order that the muscles should be moulded after the form of the viscera.

This objection appears to me of very little weight; first, because the brain and spinal marrow have always primarily existed, and have only been destroyed by a disease, when the organs had ac-

quired some degree of developement;* secondly, because those children are born dead, or, not being able to breathe, live but a short time; so that it is impossible to ascertain whether the cephalo-splanchnic muscles would follow the movements of enlargement and condensation of their viscera. These facts appear to me rather confirmatory of my opinion; since they prove the indispensable necessity of the brain for exciting into action the inspiratory muscles, which, as we have said, are necessarily associated with the other viscera, in the same manner as they are with the lungs.

Some writers speak of acephali which have executed movements before their birth. If the fact be certain, I cannot explain it otherwise than by saying, that the disease which destroyed their brain, had not yet produced its entire effects, and that it had spared at least a portion of the spinal marrow, at the moment the mother felt these movements. Do not the experiments made on limbs separated from a living animal, prove, that the stimulation of the tissue in which the nerves of those parts originate, can produce in them muscular contractions? For what reason shall we refuse to admit, that the irritation, (for it is one,) which destroys the spinal marrow, may excite convulsive contractions in the muscles?

From these considerations I am led to think, that, although the cephalo-splanchnic muscles are at the disposal of the viscera, the latter obtain only from the brain the contraction of those muscles that are necessary to them; and if they cannot be prevented by the will, it arises from this, that the stimulation which manifests the want of the viscera, exercises a more decided influence over the brain than the will, whatever be the degree of energy it may have acquired by the exercise of the intellectual operations.

It is plain, that all the convulsions of the muscles of relation are of the same kind; that is to say, they all depend upon an irritation of the brain, either primary, or originating in another part of the body, and transmitted to that organ through the medium of the nerves.

A very ingenious experiment made by M. Magendie, appears to

* This assertion is purely gratuitous, and rests upon the presumed necessity of the prior formation of the encephalo-spinal axis. But following the inductions of Serres, and Gall, and Spurzheim, we shall be more inclined to regard the nerves and viscera as of independent growth and developement, and the chief purpose of the spinal marrow and base of the brain to be for a centre of union and combination of nervous power.—Trans.

prove that the posterior roots of the spinal nerves preside over sensibility, whilst the anterior regulate muscular movements. This signifies in my opinion, that the first are distributed to the skin, and the second to the muscles;* but, be this as it may, these experiments cannot, in any way, disprove the correctness of the propositions I have just advanced.(L)

Such as I have described are the cephalo-splanchnic muscles,—always ready to be called into action,—excited by every stimulation transmitted to them; and having always the brain as an intermediate link between them and the different viscera, the functions of which they are destined to aid. It should be remarked also, that all the points of irritation, which may arise in the other tissues, act always in the same manner upon them. I insist upon this, in order that these muscles be not regarded as obeying two orders of laws; they are submitted to one only, and when the will places them under contribution, it must act upon them through the medium of the same point in which they correspond with the viscera.

Section II.—*In what manner the Exercise of the Muscles may occasion, or become cause of Disease.*

I have proved, that the distinctive character of the cephalo-splanchnic muscles, is their greater submission to the influence of the viscera: I say greater submission, because the cephalic muscles also obey them; but in order that they should do so, it is necessary that the visceral irritation should reach that degree which approaches to a pathological state; under such circumstances, the brain is compelled to place the cephalic muscles at the disposal of instinct, in the same manner as it has placed the cephalo-splanchnic. I select as examples, defecation, vomiting, the expulsion of the fœtus, and even copulation. Whenever these wants are urgent, the will is compelled to make use of the muscles, which she employs in such a way as to cause the proper attitude to be assumed, or the efforts necessary for their gratification to be made. If, by the power of the will, we refuse to gratify these wants, the call made upon the brain, or the stimulation it receives from the organ irritated by the

* We cannot conclude from this experiment, that the nerves of motion are different from those of sensation. Nature makes use indiscriminately in a thousand places, of the same nerves, for both functions, and the idea of the two nervous fluids is hypothetical.

want, would become so considerable as to pass to a morbid state: when this occurs, the cerebral irritation, converted into congestion, would cause those muscles, the aid of which was obstinately refused by the will to the viscera, to act in a convulsive manner; or else this irritation would attain the inflammatory state, and cause reason to disappear,—delirium would ensue, and the will would be changed; or, in other words, a pathological would take the place of the healthy will, and the viscera would be obeyed. It is in this way that nature is revenged for the obstacles which an improper use of the intellectual faculties opposes to the gratification of her wants; it is thus also that mania from religious causes, or from thwarted love, from excess of study or from meditation, &c. is brought on.

But if the unreasonable opposition of the will to the accomplishment of the wishes of nature, can give rise to all these evils, they may equally result from the improper use of the instinctive functions. By accustoming the will to obey the least signal of a want, we augment the empire of this want; and the cephalic muscles, too ready to gratify it, finally become as intimately united to the visceral irritations as the cephalo-splanchnic. In such cases man becomes the slave of his appetite, he is brutified, and this extraordinary influence of the viscera over the brain, produces, occasionally, the unpleasant effect of deranging its functions, of developing morbid irritations in it, and occasioning mental alienation. Independently of this, the muscles insensibly lose the power of gratifying the will, when it requires of them any other kind of movement; they become debilitated and subject to convulsions.

If we next direct our attention to the locomotive muscles, executing under the influence of the will movements too violent or too often repeated, we find a number of diseases arise, which unfortunately are of too frequent occurrence. The first of these effects is manifested in the circulation; for whenever a large number of muscles are simultaneously called into action, the blood which is called into their tissues, is sent back precipitately to the heart. This seldom fails to occur in all great efforts, as in jumping and running. Now, if the heart, notwithstanding the acceleration of its action, cannot suffice to the disgorgement of the venous system, there must necessarily result, in the viscera, sanguineous stagnations, the consequences of which we shall point out when treating of the circulatory function.

Another result of these immoderate muscular contractions, is the rupture of the muscles, or the tearing and separation of the tendons, which may be followed by very dangerous inflammations, capable of giving rise to extensive disorganization in the locomotive apparatus, and of being propagated even to the viscera.

When the muscles, moreover, are too violently exercised, they are apt to fall into an alarming state of debility. In this condition they are found, when called into action, to become engorged with the greatest facility;—they are afterwards benumbed, and exercise becomes almost impracticable. These excesses of locomotion cause them sometimes to pass to the inflammatory state. I have often seen, in soldiers, after forced marches, the muscles of the thighs become painful, and produce a chill and fever; in a word, inflame and suppurate as after the most violent attacks of rheumatism.

The articular surfaces are liable to similar accidents, whenever they are exposed to a too long continued friction. We occasionally see severe attacks of arthritis, which arise exclusively from too violent exercise. I have had occasion to remark in these cases that cold is not the only cause of the mobility of articular inflammations; for those which depended on over exertion, have also had the wandering character. Originally developed in the knees or feet, which had most suffered from exercise, these inflammations were seen to be translated upon other joints which had not been irritated by fatigue, when care had not been taken to cut them short, by means of the antiphlogistic treatment, in the parts in which they originated.

If exercise alone can inflame both the muscles and the articular surfaces, with much more reason are these parts exposed to become violently irritated, if the individual, who has exercised them too much, is so unfortunate as to remain exposed to cold after immoderate exertion; it is under these circumstances, that the most violent and extensive rheumatisms are seen to appear. The production of these diseases is rendered still more easy by sleep, if the person who is fatigued abandons himself to it without having the precaution to cover himself well. It is even sufficient that a single part of the body should be exposed to cold, while all the rest is kept warm, in order that these painful inflammations should appear: this is what often happens to soldiers, obliged to sleep two together in very narrow beds, the covers of which are not sufficiently large

to protect them completely. Sometimes, also, the heat they experience when sleeping, makes them instinctively draw out and expose a leg or an arm to the air; and it is upon this part that the inflammation appears, with so much the more intensity, I repeat, as the previous fatigue had been more considerable.

But the locomotive apparatus is not the only one which suffers under these circumstances; the circulation, which exercise had greatly accelerated, becomes languid during rest, especially at the surface, and the skin no longer resists the influence of cold; a supplementary action is developed in the viscera, where it produces serious inflammations.

A strong alimentation may, undoubtedly, prevent such accidents after undue exercises; but it is not free from all inconveniences, as I propose to show when examining the influence of muscular exercise upon digestion.

Whenever we abandon ourselves to a violent and prolonged muscular exercise, digestion is quickened, and the appetite returns sooner than usual; if it be not gratified, we experience at the epigastrium a painful gnawing, accompanied with a sensation of cold, and the muscles begin to lose part of their energy: under these circumstances, if the individual be taking a long walk, locomotion becomes slower, and the will is obliged to act with much force to keep up the step. It is in these cases that the relations which associate the stomach with the muscular apparatus, and with the brain, become most apparent. Thus, a walker who abandoned himself with pleasure to conversation at the commencement of the journey, when he had his stomach full and his limbs supple, becomes insensibly silent, in proportion as the stomach is emptied and the muscles fatigued; the attention for objects which before occupied him, gradually diminishes, and even becomes so feeble, that he not only shows a reluctance to speak, but even can only think of the muscular movement and of the want of nutrition. But let him reach a place where he can take nourishment and enjoy rest, he will be seen to resume with gaiety his journey,—give himself up once more to the pleasures of conversation, and again enjoy a degree of strength which he considered as lost: so true is it that nature only permits us to apply our powers to the exercise of thought, and to that of the other functions of relation, when the instinctive wants do not claim the employment of it for the profit of self-preservation.

Yet, as there is a limit to every great effort, the uneasiness that our traveller had already experienced does not fail to recur; but a brief rest and a light repast are now no longer sufficient to calm it; sleep has become necessary; and, if it be not obtained, a crowd of evils of the most unpleasant kind, never fail to revenge injured nature. Under these circumstances, two pathological states are to be feared, viz. inflammation and exhaustion. Thus with certain persons, the stomach, too much irritated by muscular exercise, is greatly heated, and even intensely inflamed; the painful sensation in the epigastrium, which seemed to require nourishment, becomes aggravated by its presence, and especially if it be of an irritating nature; and the man who expects to regain his strength, the evening after a fatiguing journey, by a substantial meal, seasoned with alcoholic drinks, only derives from these a gastritis, which soon gives rise to a febrile state, and prepares for him a most painful night. It sometimes happens, that this inconvenience is only temporary, and that an equilibrium is established by the exercise of the following day; but if, after being, during a long time, heated and over irritated by exercise, even after being to a certain degree exhausted, the person abandons himself to rest and good living, it will be difficult for him to escape dangerous fevers, which are nothing more than gastro-enterites.*

Hence, it is remarked that the most dangerous epidemics take place after long and forced marches, particularly in a conquered country, and when soldiers enjoy great abundance. In fact, muscular exercise ceasing to expend the vital power, this is directed towards the digestive viscera, by the excesses of nourishment and of fermented liquors to which the soldiers abandon themselves, and gastro-enteritis rages with a violence and universality, that leads to the belief of contagion. Having often been witness to such epidemics, I think it will be in my power to treat of the matter to some advantage. This question deserves so much the more to engage general attention, as the fatigues experienced by soldiers induce

* These remarks are peculiarly applicable to that numerous class of invalids called *dyspeptics*, who often deprive themselves of all the benefits of travelling and change of scene by unlimited indulgence of their appetite for food, and who falsely suppose that the languor of fatigue requires for its removal free repletion. The rules of diet to which they had adhered at home are forgotten abroad, and they too often return with increased phlogosis of the stomach and febrile excitement superadded to their former nervousness and irritability.—TRANS.

physicians to consider them as in a state of exhaustion, and to lavish upon them the most energetic stimuli, such as wine, alcohol, camphor, bark, &c. The mortality then becomes excessive and dreadful; and, far from obviating it by appropriate remedies, time is lost in searching after the means of arresting a contagion, which only exists in the prepossession of such as witness these disasters. Not, however, that infection is impossible, whenever we accumulate in too confined places the victims of these deplorable circumstances; hence, physicians and commanders ought to neglect nothing capable of preventing this misfortune. But it is not less certain, that the best means of annihilating these epidemics, is to subject the patients to an antiphlogistic treatment, as soon as they feel the first attack of the inflammation.

It was in conformity with these principles, that I was able, as I have elsewhere said, to remove in the course of a few days, in several military hospitals, pretended contagions which were attributed to the unhealthiness of the wards, without even having recourse to the disinfecting fumigations of Guyton Morvaux. It was during the last expedition to Spain, that I was enabled to make these observations; and I am persuaded, that similar precautions would have been sufficient to put a stop to the progress of the frightful epidemic, which destroyed the remnants of our army, after the campaign of Moscow. What was, in fact, the situation of these troops? They had just suffered the united torments of fatigue, cold, and hunger; and attempts were made to compensate them, during the period of rest, by furnishing abundantly the means for restoring their strength; hence they could not avoid gastro-enterites; and the incendiary treatment, a fatal consequence of the Brunonian principles of our schools, did the rest. It is not from mere conjecture, that I thus speak; I have, in support of my assertion, the formal declaration of some physicians who escaped the contagion of the stimulating system. From them I have learned, that they cured this disease with as much facility as other gastro-enterites, when they could oppose to it the antiphlogistic treatment, before it had reached that degree which has caused it to receive the too fatal name of *adynamic fever*.

In other individuals less disposed to inflammation, fatigue, arising from muscular exercise, produces a real exhaustion,—particularly if the renovation be insufficient. I have often seen soldiers enter our hospitals after fatiguing marches, motionless, withered, silent,

and as it were in a kind of imbecility. After being convinced by the examination of the tongue, which was pale and large, by the want of pungent heat at the epigastrium, &c. that this adynamia was not the result of a gastro-enteritis, I gave them wine, at first with very little nourishment; I gradually increased the dose of these stimuli, and I soon had the gratification of seeing them entirely recovered. In fact, it is for fermented and alcoholic drinks, that the stomach has a relish under these circumstances; undoubtedly, because they diffuse, with more rapidity than the fixed tonics, the excitement throughout the whole extent of the nervous system, and repair promptly the losses it has sustained. At any rate we cannot too often repeat, that great caution is necessary in directing the application of this plan of treatment; because nothing is more easy than to confound the adynamia which depends on exhaustion, with that produced by inflammation; and because persons who are fatigued pass easily from the first to the second.

When, without being excessively violent, muscular exercise is too much prolonged, its effects are less prompt and less dangerous; but they are still very serious. Examine those hard labourers, those workmen of the lowest classes of society, whose renovation is no ways proportioned to the waste of their strength; they at last waste away; their limbs become stiff and tumid, their movements slow and painful; their skin wrinkles and withers; they grow prematurely old, and many among them become asthmatic. This asthma appears to me to be owing, most generally, to an affection of the heart, which, after having acquired more energy and volume, by participating in the irritation of the other muscles, and by the too hurried circulation of the blood, becomes weak, relaxed, and often aneurismal. They are also subject to chronic catarrhs, the resolution of which does not take place, and fall victims to a lingering pneumonia, which physicians have endeavoured to constitute into a peculiar disease, under the name of *phthisis with melanosis.* But what is most remarkable in those patients, is the dryness, the stiffness, or the varices of the lower extremities, which deprive them early of the corporeal labour which constituted their only resource. Their bones are also seen to bend, especially towards the vertebral column, and become the seat of rheumatic pains, which nothing can dissipate.

Such are the diseases caused by an abuse of the muscular power: it may be perceived, that they affect the cephalic muscles, and par-

ticularly those of locomotion. Those connected with the functions of the viscera, suffer much less; because they are not subjected to such considerable efforts; yet they are not always exempt from fatigue, and even from serious accidents. The diaphragm has been known to be torn in violent efforts. The abdominal muscles become fatigued, and even extremely painful, in walking. The intercostals, compelled, in conjunction with the preceding, to keep the chest immoveable, in order to serve in violent efforts as a point of support to the muscles of the limbs, give rise sometimes to a feeling of fatigue and pain. Those of the neck are not free from it; but, in general, the labour of these muscles is much less considerable than that of the muscles of the limbs, of the sacro-lumbalis, of the longissimus dorsi, and of all the fleshy masses situated posteriorly along the vertebral column.

Fatigue is, for the moving apparatus, a pain which is perceived in those muscles that have been too much exercised, and which warns us of the necessity of rest; it depends on a local irritation; and if overlooked by the percipient centre, and persistingly excited, it is changed into an inflammation or into a neurosis, in the same way as that which follows excessive action in the most important viscera of the economy.

CHAPTER XII.

A SUMMARY OF THE FUNCTIONS OF RELATION.

I. There exists in perfect animals, and in man, who more particularly engages our attention, a nervous apparatus designed,—first, to put them in relation with external bodies; secondly, to establish relations between the different organs composing them.

II. The nervous apparatus is presented under three forms; first, sensitive expansions, which are both external and internal, and which are found in the skin, and the other external senses, and in the internal surfaces called *mucous membranes;* secondly, the central nervous matter, which is placed in the cranium, and extends into the spinal canal; thirdly, the sensitive cords or nerves, esta-

blishing a communication between the surfaces and the central nervous matter.

III. It is to the basis of the brain, (*medulla oblongata,*) that all the nerves converge. The spinal prolongation, and all the cords which communicate with the external nerves, whatever be the point of the cranial cavity through which they penetrate, are regarded as the intermediaries between this point and these same nerves. The rest of the encephalic apparatus is regarded as a union of nervous systems, which equally terminate at the medulla oblongata. These systems preside over the intellectual operations, and their action gives rise to thought, ideas, judgments, memory, prescience, and to the consciousness of existence, which makes man say *I feel*, *I do*, *I am*, which gives the idea of *self.*

IV. The wants are the source of all the relations; they originate in the organs, and produce stimulations in the internal sensitive surfaces. These stimulations, having reached, by means of the extra-cephalic nerves, the cerebral centre, produce a feeling of our wants; but it is a confused one.

V. When external bodies, destined to gratify these wants, are present and act upon the external surfaces of relation, they are recognised, by the centre of perception, to be in relation with the wants; and the feeling of these latter becomes more clear and urgent.

VI. The recognition of external bodies, proper for the gratification of the wants, supposes that the stimulation produced by the former, has been reflected by the cerebral centre to the viscera; and that these, in consequence of their wants, have responded to the centre of perception, whence results instinct. This recognition supposes also, that the same stimulation has been reflected to the intra-cephalic nervous apparatus, which have likewise responded to the cerebral centre, in order to unite the intellectual operations with the instinctive movements. The proofs of these facts are very numerous.

VII. The stimulations coming from without, and perceived by the cerebral centre, after a repetition in the nerves of the viscera, and in the intra-cephalic nervous systems,—these same stimulations, which give the decided feeling of the wants,—are called *perceptions.*

VIII. Perceptions supposes, that the encephalic apparatus is

sufficiently developed, and that it is in the waking state; for every soporose state, natural or pathological, puts a stop to perception; but does not prevent the stimulations of the sensitive surfaces, whatever they may be, from reaching the brain. Hence, perception is never continued, even in the natural state; whereas, the stimulation of the brain, from that of the sensitive surfaces, never ceases.

IX. Perception and stimulation of the brain determine muscular movements; but they are very different from each other. Those that result from perception, supposing that instinct and the intellectual faculties preside over them, are regular, have a determinate object, and disclose the thoughts of the individual and the intention of *self;* in a word, the will: these constitute *acts.* The movements which are merely the effect of the cerebral stimulation, without perception, are irregular, sometimes convulsive, and reveal neither thought nor will.

X. Sometimes, in spite of the waking state and the existence of consciousness, the brain receives stimulations that make it execute movements of which the individual is conscious, but which the will cannot prevent. Hence stimulation and perception may take place at the same time, and in an independent manner. These cases are always unnatural, and consequently pathological.

XI. When perceptions are occasioned by external bodies which interest intimately an instinctive want which is at the same time urgent, the will is strongly solicited to cause those acts to be executed which are requisite for the gratification of the want, without the intervention of the intellectual faculties; because the influence of the visceral nerves predominates over that of the nervous apparatus destined for the intellectual operations. Yet the extreme developement of these last apparatus in our species, and the habit of exercising them, which is acquired in adult age, give us the faculty of calling for the intervention of the will in these acts, so as to modify some of them, retard others, and prevent a great number; hence, instinct never acts with liberty, that is to say, does not carry away the will despotically, in the adult and civilized man. This resistance is attributed to what is called *self,* which always supposes the exercise of judgment. But in early infancy and during sleep, instinct overpowers the will;—because perception is not clear, and then it is said that reason is wanting.

XII. Whenever the brain is too suddenly, that is to say, patho-

logically stimulated, *self* does not so fully enjoy the faculty of modifying the impulses of instinct; often, in such cases, the will obeys the last, and it is said that reason is not the mistress, and often that it is alienated. This is what happens in insanity.

XIII. When the brain is stimulated by pathological irritations, either acute or chronic, it produces, in presence of the will, in spite of its influence, and often unknown to it, a number of unnatural movements, and various sensations, which are sympathies of relation, and become, in the eyes of the physician, the signs of the disease.

XIV. When the perceptions that reach the brain do not interest intimately an urgent want, they never fail to be reflected to all the nervous apparatus; but those of the viscera responding less than the intra-cephalic to the cerebral centre, perception is more in the domain of intellect than in that of instinct, to which, however, it may be linked by other ideas, that is, by other perceptions, to which memory and prescience may give rise. Perceptions of this kind are relative to the sciences, arts, &c.; they serve for the gratification of the wants of thought and of observation, which are characteristic of man. Hence *self* is exercised upon wants of every kind; in other words, on the instinctive and intellectual wants; giving rise to the affections and passions, as has been elsewhere exhibited in detail.

XV. Every external sensitive surface may become diseased in the exercise of its functions, by inflammation, sub-inflammation, hæmorrhage, and neurosis.

XVI. The brain, when excited to action by stimulations and perceptions, reacts upon the viscera and muscles. There are, therefore, two kinds of action;—the visceral and the muscular. The first produces stimulations that are reflected to the brain, and redouble its irritation; it becomes a cause of health or of disease, according to its intensity and to its repetition. The diseases of the viscera which depend upon it, consist of congestions, inflammations, hæmorrhages, and neuroses. The second action occasions movements of locomotion.

XVII. The fibrin of the muscles is always in a state of contractility during life, and even for some time after death; it communicates with the brain by means of the nerves, and with the circulating centre by means of vessels. When forced suddenly to an increase of contractility by the innervation of the brain, it becomes con-

densed; its fibres are shortened; this is what is called *contraction;* under these circumstances, locomotion of the whole body, or of some one of its parts, is produced. The muscles carry with them the bony pieces, upon which they are fixed, and which move upon each other.

XVIII. When the brain is in a waking state, locomotion is perceived, and may become painful.

XIX. Whenever the muscles receive an over increase of nervous stimulation and contract, there is an afflux into their tissue of a larger quantity of blood, which they propel into the veins with a rapidity proportioned to that of the arrival of this fluid. From this it results, that muscular action accelerates circulation, and may give rise to great disorders in this function.

XX. The muscles are all in immediate dependence upon the brain; but they must be divided into *cephalic*, which, in the natural state, obey the stimulus of the brain only, with the consent of the will; and into *cephalo-splanchnic*, which obey the viscera through the intermediate agency of the brain, in spite of the will, and also obey the latter, though only when the viscera are not in want of their assistance.

XXI. The cephalo-splanchnic muscles never act in obedience to the will, unless the viscera with which they are associated have undergone some modification.

XXII. Muscular action becomes a cause of disease by its influence on the circulation;—by the rupture and acute or chronic inflammation of the fibrin of the muscles, and of the other tissues of the locomotive apparatus;—by irritation transmitted to the stomach;—by exhaustion of the nervous power; and by producing a general languor, which favours the action of causes calculated to derange the equilibrium, and especially of cold.

END OF PART I.

PART SECOND.

ORGANIC FUNCTIONS.

PART SECOND.

ORGANIC FUNCTIONS.

CHAPTER I.

OF THE ORGANIC FUNCTIONS IN GENERAL.

All the functions have for their object the preservation of the individual; but some accomplish this by establishing a connexion with external bodies, such as those that we have examined; while others, the study of which is next to engage our attention, fulfil the same purpose without the intervention of any external agency.—We find, indeed, relations, but they only take place between the various apparatus of the same order; since the organs charged with the office are connected, on one side with the brain, to which alone belong the extra-individual relations, and on the other side with the interior of the tissues.

It is this connexion that regulates the order of the internal movements, and the direction of the fluid or of the mobile animal matter, which always follows in their train. In fact, when this has reached its destination, it is obedient only to the molecular affinities of life, which I have designated by the term living or vital chemistry.

The functions circumscribed within the sphere of the animal, will be susceptible then of a subdivision. They might be divided into intra-individual functions of relation, and into vital chemistry, the latter comprehending assimilation, and all the transformations of animal matter; some of which result in the formation of fluids different from the blood, and others in the solidification of this mobile matter, or in *nutrition*. Still, however, as many internal apparatus exhibit the union of these different vital operations, and as it would be inconvenient to separate the histories of them, I

shall not adopt rigorously any new classification. When I come to treat of an apparatus in which several of the phenomena above-mentioned are combined, I shall speak of all that is necessary to the understanding of its function; finally, when all the appreciable movements shall have been examined, I shall then arrive at the phenomena in which nothing more can be observed than the movements that take place among the molecules. This arrangement seems to me preferable to any other, in the actual state of our knowledge; and, to prepare my readers for it, I now offer the abbreviated outline:

1. The Nerves of the Organic Functions.
2. The Function of Respiration.
3. The Function of digestion, or primary Assimilation, with evacuation of its superfluity.
4. The Absorption of Nutritive Materials.
5. Circulation.
6. Depuration.
7. Secretions.
8. Internal Exhalations.
9. General Absorption.
10. Nutrition.

Such is the physiological history of the individual; then will follow that of its reproduction, in which we shall see the result of a particular act of nutrition, or a prolific nutrition, produce the re-appearance of almost all the phenomena already observed in the physiological life of the parents. By this course we singularly facilitate our study, and prevent the confusion that would have followed from blending generation with the other phenomena of the living body.

Many authors have already separated generation from the other functions; regarding these latter as peculiar to the individual, and the first as belonging to the species. I have not been guided by the same motive, but have only been induced to imitate them, because it was impossible for me to separate the phenomena of reproduction, so as to refer them to the different functions that compose the history of the physiological life.

CHAPTER II.

ON THE NERVES DESTINED TO THE ORGANIC FUNCTIONS.

Anatomists have bestowed the name of *great sympathetic* on a very complicated nervous apparatus, situated deep in the interior of the body, and which, in fact, establishes communications between the principal organs. It is composed of a series of ganglions connected together by means of filaments: these ganglions are reddish bulgings of tolerable firmness, in which we find gelatin, and a little fibrin. Those of the head are almost entirely buried in cellular tissue, and are placed beneath the basis of the cranium, or between the bones of the face; those of the trunk are situated on each side of the spinal column, in lines, from the upper region of the neck to the os coccygis. Besides the communicating filaments that join the ganglions together, as in a kind of chaplet, numerous cords are given off, which proceed to various kinds of organs. These cords have nearly the same intimate structure as the cerebral nerves; that is to say, a gelatinous tunic, containing very small cylinders in undetermined numbers: the white pulpy matter analogous to that of the brain is not distinguishable in them; their consistence is very great, and their colour of a grayish white.

The ganglionic cords may be divided into three series: the first is connected with the nerves of the encephalic domain, whether cerebral or spinal, and passes with them to the muscles and the viscera; the second plunges directly into the viscera; the third embraces the arteries and forms a plexus round their tunics, to the extent of sometimes enclosing them as in a kind of sheath.

The known ganglions at the base of the cranium and face are, 1. the ophthalmic, situated deep in the orbit; 2. the sphenopalatine, occupying the region of the same name; 3. the cavernous, placed in the sinus of the same name; 4. the nasopalatine, discovered by M. Cloquet, in the anterior palatine foramen; 5. the sub-maxillary, on a line with the gland of that name. These ganglions, in addition to their communications with each other, furnish filaments as follows: (*a*) *muscular cords* to all the nerves which excite to motion the muscles of the eyes, internal ear, palatine arch, and face; (*b*) *visceral cords*, to the tissue of the eye, forming the ciliary processes, and lost in the iris; to the salivary glands, and to all the

regions of the mucous membrane which lines the cavities of the bones of the face; (*c*) *vascular cords* to the arterial branches, that convey the blood to all these organs, or which penetrate into the cranium.

The ganglions of the neck are three in number: the superior, the middle, often wanting, (and then the superior extends lower down,) and the inferior. Connected at first with each other, as well as with the preceding ones, they furnish (*d*) *muscular cords* which proceed to all the muscles of the neck, together with the cervical nerves, that have the same destination; and to the muscles of the os hyoides, tongue, larynx, pharynx, and to the phrenic nerves; (*e*) *visceral cords* to the trachea, œsophagus, thyroid gland, and lungs; (*f*) *vascular cords* to the arteries of the neck, the subclavian, &c. giving also branches to the arch of the aorta, which contribute to the cardiac plexus.

The thoracic ganglions begin by the one called *cardiac;* it furnishes the anterior and posterior coronary plexuses, which embrace the aorta at its origin, and pass, with some branches of the eighth pair, into the muscular tissue of the heart; it supplies also the coronary arteries, the aorta, and the pulmonary artery. After this ganglion, we meet with twelve other smaller ones, situated on each side of the fore part of the head; they are united by filaments of communication never numerous, and give (*g*) *muscular cords* to the dorsal and the intercostal nerves; (*h*) *visceral cords* to the pulmonary plexus. On each side, filaments are detached, which meet at the middle of the dorsal column to form the splanchnic nerves destined for the abdominal viscera. We shall resume the subject of these nerves, in order to follow their distribution; (*i*) *vascular cords*, but few in number, to the aorta.

The lumbar ganglions are a continuation of the vertebral series: sometimes, however, this is broken at the last thoracic ganglion; then the communication is continued by means of the splanchnic nerves, which have multiplied connexions with the lumbar and sacral ganglions. The lumbar are arranged on both sides of each vertebra, as far as the the sacro-vertebral articulation, and always communicate with each other in the same manner as the preceding; they furnish (*k*) *muscular branches* directly to the psoas, and, by anastomosing with the lumbar nerves of the encephalic domain, to the other muscles of the loins, and to those which form the parietes of the abdomen; (*l*) *visceral branches;* some twigs are detached from these to aid in the formation of the hypogastric plexus; but

the splanchnic nerves which are given off from the vertebral series in the thoracic cavity, and also in the abdomen, are destined to supply the principal viscera of this latter; (*m*) *vascular branches*, forming a net-work round the abdominal aorta.

The sacral ganglions terminate the vertebral series. Placed on each side of the inferior surface of the sacrum, these, to the number of three or four, furnish (*n*) *muscular branches* to the pyramidal muscles, and to the levator ani, either immediately or by anastomosing with the sacral nerves of the encephalic domain ; (*o*) *visceral branches:* the internal filaments of the great sympathetic are united on the sacrum, with the sacral nerves, to form the plexus called *hypogastric*, whence go out cords, of which many pass directly from the great sympathetic to the bladder, vesiculæ seminales, rectum, uterus, vagina, and anus; (*p*) *vascular branches*, surrounding all the arteries which are distributed to the above mentioned organs, by cords that are given out from the same plexus.

The vertebral series of the great sympathetic is sometimes terminated by an arch formed by the union of the nerves of both sides, and at times ends in a ganglion situated near the coccyx.

Let us now notice the two cords called great and little splanchnic, which are detached from the vertebral series in the chest, to be distributed to the viscera of the abdomen, after having passed through the diaphragm. The great cord goes to form the semilunar ganglion; the little is lost in part in the first, and in part in the renal plexus.

The semilunar ganglion is situated on a level with the cœliac trunk, over the aorta and the crura of the diaphragm; the two ganglions unite at the median line, and form the *solar plexus*, reinforced by the eighth pair. This plexus, made up of an interlacing of nerves, mixed with ganglions, embraces the aorta, the cœliac trunk, and the crura of the diaphragm, and gives origin to the following secondary plexuses. 1. The *sub-diaphragmatic*, which embraces the artery of the diaphragm and follows it to its termination ; it furnishes also filaments, which are detached, some to plunge into the muscular fibres, others to unite themselves to the phrenic nerves ; thus we find here the three usual destinations of the great sympathetic. 2. The *cœliac plexus*, or inferior prolongation of the solar; it supplies the aorta, the gastric coronary, and the hepatic and splenic arteries: filaments are given off which enter into the pancreas and the other viscera. 3. The *superior mesenteric plexus*, surrounding the artery of that name, whence pass filaments

to the intestines. 4. The *inferior mesenteric plexus,* which is distributed like the preceding. 5. The *renal* or *emulgent plexus,* which comes in part from the solar and cœliac, and from the semilunar ganglion, and in part from the smaller splanchnic nerve already spoken of; it accompanies the arteries, and furnishes filaments directly to the kidneys. 6. The *spermatic plexus,* furnished by the two preceding ones; it accompanies the arteries: we are unable to say whether filaments are given off from it, which penetrate directly into the testicles and the ovaria, but we may, from analogy, presume such to be the case.

We have seen that the arteries have their own ganglionic nerves, which are blended with their tunics, and moreover, that they serve as conductors for these nerves to pass, either to the muscles, or to the viscera, which confirms the more the office of the great sympathetic. It may also be observed, that no where is this nerve so considerable as in the abdominal viscera, which coincides perfectly with the part that was assigned to the digestive organs, when examining their relations with the brain, and also with the intellectual faculties and the passions.

We have hitherto presented anatomical facts; we must now set out from the data which they furnish in order to form an idea of the functions of the great sympathetic.*

It is proved that the nerves coming from the brain are the channel for the sensations, which from various parts of the body go to the centre of perception and volitions; that is to say, the influences under which this latter determines movements. These two phenomena which constitute *innervation* are, on final analysis, but modes of general irritation. The cords of the great sympathetic are continuous with the cerebral nerves, and are to be considered, like these latter, as conductors of irritation. This granted, it must of necessity follow, that the irritations which are developed in the viscera, where the great sympathetic predominates, should be communicated to the cerebral nerves, and by them conducted to the encephalic centre. It is also equally indispensable to admit that the irritations, or volitions, emanating from the brain, should

* The reader who is desirous of having a true picture of the origin and distribution of the great sympathetic, will be fully gratified by a reference to the beautifully coloured lithographic engraving of this nerve, of the natural size, executed by Mr. Ancora of this city, and for sale by him, at his residence, No. 145 Pine street. On the same sheet is a minute anatomical detail of all its ganglions, plexuses, and connecting cords and filaments.—TRANS.

be carried into the ganglionic nerves, and penetrate by means of these latter into the tissues in which these nerves are distributed. There is then reciprocity of stimulation between the encephalic and ganglionic nerves; that is to say, they serve as excitors of each other.

Let us next inquire into the differences of excitation observed in the two orders of nerves.

In all the organs in which we find cerebral nerves only, it is observed, that a stimulus developes a lively sensation; but it is likewise known, that this latter does not force the will, but merely solicits it, and that the percipient centre may resist, and refuse to execute the acts which it demands: such is the case with the skin, the subjacent tissues, and the locomotive apparatus. But if the parts to which the cerebral nerves communicate much sensibility, are at the same time provided with ganglionic nerves, the stimulations therein developed are no longer limited to soliciting the will by pain or pleasure; they force it: such are the expansions of the external nerves, and the internal sensitive surfaces or mucous membranes of the throat, larynx, bronchia, stomach, rectum, vagina, neck of the uterus, &c. It is then quite natural to attribute sensibility in these regions to the cerebral nerves, and the violence done to the will to the great sympathetic; in other words to the stimulation which this nerve transmits to the brain.

There is another fact, confirmatory of the preceding. The tissues, in which the cerebral nerves either do not exist at all, or are found in very small quantity, but which are abundantly supplied with cords coming from the great sympathetic, evince no sensibility in their ordinary condition; and yet, they possess the property of forcing the brain to the performance of the movements which they require; and also of influencing thought, and modifying powerfully the intellectual and affective faculties: such are the small intestines, if we except the duodenum, which has cerebral nerves and is endowed with sensibility. The influence of these parts on the brain being felt without pain, may quite naturally be attributed to the great sympathetic nerve alone. Thus, then, sensibility, on which the intellectual faculties are founded, would belong to the cerebral nerves; and the forced movements, which are all in the domain of instinct, would depend on the influence of the great sympathetic.

So far the distinction seems very clear, but now come the difficulties.

Sometimes excessive pains, even of the external parts to which the great sympathetic does not extend, such as of the skin and the

articulations, determine an involuntary agitation, and may even go so far as to excite delirium, as I have seen in a most violent case of arthritis.

To this I would reply, that all the perceptions being, as I have proved, reflected from the brain to the viscera, the irritation caused by an excessive pain must be transmitted to the great sympathetic, and thus arouse all the phenomena of instinct, to which is reserved the privilege of forcibly drawing after it the will. Nothing, indeed, is more evident than this transmission, since it is distinctly perceived by a sensation which is referred to the epigastrium, every time that pain or pleasure is carried to a high degree of intensity. It is thus, that the intellectual faculties are linked with the passions; and, in the case before us, it is by means of the instinct of preservation, that the stimulation of the external tissues succeeds in triumphing over the most marked opposition of the will.

A second difficulty would seem to be raised against the distinction which we have just established. Percussions exercised upon the epigastrium, produce a pain of little acuteness indeed, but yet extraordinarily painful, and which we characterize by the epithet *dull* or *obtuse;* whilst, on the other hand, the small intestines, by the effect of stimulation in chronic phlegmasiæ of these parts, ultimately cause different kinds of pains, and are even the seat of real colics. In these cases, is the great sympathetic nerve not at all affected? and can we avoid attributing the pains to it rather than to the cords of the eighth pair, which are here met with in such small proportion? I had at first, on the faith of experiments, admitted that the great sympathetic is insensible; but many celebrated physiologists, among whom is professor Lobstein, grant that it has sensibility. Their reflections have suggested to me others, which I shall now submit to my readers, with the hope of aiding in the solution of so difficult a question.

The experiments made on the sensibility of this nerve in animals, have not, I know, furnished any positive results. When the cords or ganglia were irritated, the animal gave no signs of pain: even granting this, have we a right to conclude, that it did not feel dull or obtuse pains? Besides, though it were certain that there existed no pain in those irritations of short duration, it would not thence follow that a chronic irritation was incapable of making it feel any; no vivisection can demonstrate the contrary; for, in case the animal were suffered to live after these experiments, the phlegmasiæ that would ensue from its wounds would interest too many

organs, to allow us to distinguish, in the pains thence arising, those that belong to the great sympathetic; the more so, as the animal is destitute of language, by which alone the thing could be explained. I will go farther. Even though the subject should happen to be a man, suffering, for example, from wounds of the abdomen, operations for hernia, &c. yet peritonitis, gastritis, and traumatic phlegmasiæ, would be productive of painful sensations, capable of masking those others, always more obtuse ones, which might depend on the great sympathetic.

No experiment sufficing to prove the insensibility of this nerve, we must then have recourse to pathology, to determine to what extent it is capable of feeling pain. As it seems to me to be demonstrated, that in a state of perfect health, or regular order of functions, this nerve is not sensible, I shall next lay down the position, that it is not any more so in the acute phlegmasiæ, at least in the manner of the encephalic nerves; since *enterites* of the highest grade, which correspond with the *adynamic fevers* of writers, are not accompanied by pains of the small intestines, in which the great sympathetic predominates. But I am of opinion, that the general uneasiness, convulsive pains of the locomotive apparatus, and cephalalgia, are sympathetic, and depend on an irritation of the ganglionic nerves, to the stimulation of the brain by which I attribute these disturbances; a stimulation which, though it be not painful in the nervous tissue, where is its primary seat, becomes so the moment after, either to the brain or its membranes, and to the sensitive, nervous, muscular, and cutaneous expansions, into which the encephalon soon reflects them; hence, in this instance, the great sympathetic nerve, without being itself painful, may cause pain to be felt in the cerebral nerves.

Lastly, we have the chronic phlegmasiæ of the small intestines, which unquestionably present us with the irritations most circumscribed within the domain of the great sympathetic. Accordingly, in a great number of subjects, they are not painful; they hardly become so except in temperaments eminently nervous, and especially if they have been long exasperated by the employment of stimuli. Such is the case in numbers of hypochondriacs, who have made inordinate use of those kinds of medicines.

I wish we could determine whether the pains in peritonitis, which are so terrible, have not their principal cause in inflammation of the abdominal ganglions and plexuses. One fact would seem to negative this supposition; it is that inflammations of the

coats of the visceral arteries, which are so abundantly supplied with ganglionic cords, do not cause any great pain. This question will perhaps be solved by pathological facts, or by the experiments of vivisectors.

If, in order to clear up the subject of the sensibility of the great sympathetic, we were to appeal to the sensations which accompany powerful passions, some light might be perhaps thence thrown on it. Thus, the epigastrium, to which the greater number of them are referred, receives many cords from the eighth pair, whilst the small intestines, and also the liver, which do not give rise to any sensations during mental emotions, are almost entirely under the dominion of the great sympathetic. We may remark, also, that the bladder, the genital organs, the anus, the throat, the bronchia, to which we refer a crowd of sensations in the affective movements, are more rich in cerebral nerves than in cords from the great sympathetic. As to the heart, so abundantly furnished with these latter, nobody is ignorant of the great obtuseness of its sensibility, and of inflammation being required to raise it to the grade capable of giving rise to acute pain.

It seems to me, as an inference from all these facts, that the great sympathetic is not sensible in its natural state, but that it may become so in a pathological condition, when modified by inflammation. In other words, this nervous apparatus receives from the brain stimulations, which cease to produce sensations when they arrive at its tissue; it transmits to that organ stimulations which, though not felt in its own structure, become more or less so at the moment when they are communicated to the encephalic nerves; but the state of inflammation, especially of the chronic kind, may entirely change this mode of action, so that the individual acquires the perception of the irritations of the great sympathetic, and has the consciousness of numerous internal movements, from which he is naturally free in the physiological or ordinary state.

After having discussed the question of the sensibility of the great sympathetic, let us examine that relating to the movements over which it presides.

To understand it, we must still take anatomy and pathology as points of departure.

Since cords of this nerve go to muscles, they must necessarily be co-operative in the movements of the latter. These muscles are of two orders: some form a part of the locomotive apparatus, such as the muscles of respiration, which we have called *cephalo-splanch-*

nic; others belong to the viscera, and ought to be designated under the term *splanchnic.* The great sympathetic must perform the same functions in these two series; and, if it determines involuntary movements in the respiratory muscles, it is quite natural to believe that it produces them in the heart, and in the muscular coats of the hollow viscera. As then we know of no other influence but it, which can account for the association of the cephalo-splanchnic muscles with the viscera, in despite of the will; so likewise we are inclined to attribute to it the independence of volition, which we observe in the heart and other splanchnic muscles. In fact, if we explain the alternate obedience of the cephalo-splanchnic muscles to the viscera and the will, by the union, in their tissue, of the cerebral and ganglionic nerves; we must attribute the obedience to the viscera, and resistance to the percipient centre, which we remark in the splanchnic muscles, to the great predominance of the ganglionic nerves, which never allow these muscles to stop in spite of the express command of the will. Such is a general idea of this grand phenomenon; but it is susceptible of certain developements, indispensable to an explanation of various shades, observed in the natural stimulations that keep up and modify the action of the splanchnic muscles.

In the first place, we find that such of the muscles of this class as are attached to a mucous surface, or to one of relation, are obedient to the stimulation of one or other of them. It is thus that, in the stomach and intestines, the irritation of the mucous tissue determines the contraction of the muscular parietes; so that we may say, that this belongs to the order of sensitive surfaces. But it is not so with the heart; the membrane which lines it is not organized like a mucous one, nor is it furnished with papillæ; it performs no sensitive function; it has a nearer relationship with the order of serous tissues, which are not required to give rise to a play of sympathies in a natural state. Whence comes then the stimulation which produces the contraction of the heart? It was at one time attributed to cerebral innervation; but if it depended exclusively on this, it would be in the perceptive series, and volition might accelerate the systole, prolong and prevent it by retaining the organ in immobility: now this is what does not happen. The stimulus of intellectual operations, and all irritations of the brain, may truly accelerate the contraction of the heart, but this process is independent of the will; and it is not in the power of volition to arrest this organ's movements. It is in spite of the will that the brain, in its excess

of innervation, excites the heart; nor even then does it disturb it exclusively, nor after any fixed intention; its action on it is only of a general kind, such as that on all the tissues charged with organic functions; and when it has darted towards it a stimulation, this persists during a certain time in despite of its most express orders. Were it otherwise, we would stop the palpitations from fear, anger, &c. which never can be done. All that the will can accomplish, is to ward off the ideas that excite the heart, and then the palpitations are gradually calmed, owing to their being no longer supported by the causes which produced them; but never do they suddenly cease at the determination of the will, as happens in the contractions of the muscles purely cephalic.

The involuntary influence of the brain upon the heart is then proved, in the circumstances of mental excitations, and extraordinary organic irritations of the encephalon. But does it exist without these conditions? Is it constant, and is it not merely exalted in the cases we have just cited? I think we may reply affirmatively to this question. The experiments of Legallois have shown that the destruction of the spinal marrow was followed by a cessation of the heart's action; pathology proves that the contractions of this viscus become slower in apoplexy, and in all compressions of the brain; even sleep is sufficient to produce the same effect. Still, however, this interruption never takes place suddenly; the privation of cerebral influence must be prolonged for a certain time, for the heart to cease acting. When this organ is suddenly extracted from a young and vigorous animal, we see it of itself perform some contractions, and, when at rest, it may be made to contract for some time, by stimulating it with the point of a scalpel, or by galvanizing it: but as it participates with other muscles in this irritability, we do not desire to draw from this any particular deductions; we will only remark, that the heart is the most irritable of all the muscles.

The main conclusion at which we ought to stop, is that the action of the heart is kept up by the influence of the brain; in other words, that the cephalic nerves communicate to its fibrin the stimulations which cause it to act. But, on the other hand, as these stimulations cannot be regulated by the will, we are led to the opinion that they are governed by the ganglionic nerves. Hence, then, we may lay down as a maxim, that these nerves receive irritation from the cerebral ones, and modify it so as to make it serve for supporting the functions of the heart. Still more, these nerves are destined to subtract continually from the brain the necessary stimulation for

this purpose, without waiting for it to undergo extraordinary exaltations of action, and even when the will would refuse to furnish them with the stimulus. I see no other means of explaining the continued action of the heart, so necessary to the preservation of life. At any rate, the extreme irritability of this muscle renders it sensible to another stimulus: the approach of the blood is sufficient to excite it, by an impression communicated to its mass, and without the necessity of an internal sensitive expansion analogous to what is found in the other hollow viscera.

At present I think I may assert, that the part filled by the great sympathetic, in relation to the other muscles in which it prodominates, and which I also call *splanchnic*, cannot be of a different nature from that with which it is evidently charged, in reference to the heart. This nervous apparatus must then make a continual call of stimulation on the brain and spinal marrow, by means of communicating nerves, in order to support the irritability of the muscular coat of the stomach, intestines, and uterus, so that this coat may respond to the irritation of the mucous surface to which it is adherent. It is not necessary that the muscular fibres, stimulated by the excitations received by the mucous tissue, should wait, before obeying, for the consent of the will; such tardiness would not suit the purpose of nature; but it is very certain that, whenever the brain pours its influence in an extraordinary manner into the eighth pair, and for the same reason into the great sympathetic, the muscular planes of the viscera are more promptly obedient to the stimulations of their mucous surfaces. It is equally true, that when the brain is compressed, and the soporose state exists, the stimulations of the mucous surfaces bring into action, with much more difficulty, the muscular planes which are adherent to them.

But if the ganglionic nerves of the splanchnic muscles borrow action from the cerebral nerves, they also communicate it to them. Thus, when a hollow organ is to expel its contents, and meets on the part of the sphincters, and cephalic muscles which strengthen them, a resistance beyond the power of its muscular coat to overcome, this organ calls to its aid, by means of the cerebral nerves, the respiratory muscles, especially the abdominal ones, and the diaphragm; and their efforts being associated with its own, it succeeds in performing expulsive movements; as always happens in vomiting, defecation, child-bearing, and even in the ejection of the urine, when the bladder, too distended, is made to evacuate the fluid by which it is filled.

This is my conception of the part performed by the muscular cords of the great sympathetic: that filled by the visceral ones cannot be very different. In fact, those which are not destined for the muscular coats of the viscera, must associate the mucous membrane of the latter with the brain; hence the call of cerebral nervous influence for the prehension of aliments, when appetite is felt, and for digestion in the gastric passages; hence the expectoration for the trachea-bronchial mucous membrane; the excitation of movements necessary to generation, for the sexual organs; hence, in fine, the augmentation of the secretion of mucus under the influences of the passions, for all the membranes of relation. I am aware that such connexions may be attributed to the cerebral nerves, which are distributed to the above membranes; but I cannot believe that the ganglionic cords are foreign to these phenomena, since we find the same relations in the mucous membranes of the small intestines, where the cerebral nerves do not penetrate. Besides, the sensibility of all these membranes is so different from that of the tissues, in which the cerebral nerves alone are found, that we cannot but attribute it to the great sympathetic.

The cords of this nerve which plunge into the large secretors annexed to the hollow organs, as the salivary gland, the pancreas, and the liver, must associate the secretion, on one side, with the mucous membrane of the alimentary canal, and, on the other, with the brain; and they can only accomplish it by their communication with the nerves of the latter. As to the kidneys, I believe them to be associated with the inner membrane of the stomach, with that of the bladder, and with the brain; and, as the ganglionic cords are the only ones which appear to animate them, I cannot but see in them the agents of these sympathies. If they receive cerebral filaments, it must be in a very small proportion, as in the case of the small intestines and of the liver; all which only serves to confirm the necessity of ganglionic cords to establish that degree of vitality observable in the viscera, whose action is never interrupted, whose normal or standard sensibility is necessarily obtuse, whose sympathies are, notwithstanding, always active, and whose influence on the brain is irresistible.

It remains for me to treat of the part performed by the vascular cords of the great sympathetic. At times these cords only accompany the arteries in their course in order to reach some one of the precedingly mentioned destinations, while at other times, again,

they are lost in the coats of these vessels. It is of the latter that I now propose speaking.

If attention be paid to the scheme of nature, in giving ganglionic cords to the arteries, we shall see that they are furnished to these latter every time that they pass near a ganglion or a plexus; now, this proves in my mind, that those twigs which had been before given off, terminated in, that is to say, are blended with, the arterial coats. If, in fact, the only object had been always to pass these nerves on with the arteries into the capillary tissues, large cords would have been given which would have proceeded on without disappearing until the point at which the vessels had reached their place of destination, or which would have left them in the middle of their course. This last is the mode adopted, when the arteries are made use of as conductors to pass on the nerves into the viscera and cephalo-splanchnic muscles; but it is not with this view, that so very many small twigs are blended with the arterial coats. We may, I think, conclude from this, that a great number of splanchnic nerves are destined for the coats of the splanchnic arteries; and as, on the other hand, we see their place supplied in the muscular, cutaneous, osseous, ligamentous, and other non-visceral tissues, by cerebral nerves, we are authorized in believing that the arteries of the visceral domain participate in the mode of sensibility of the viscera, and are associated with them sympathetically, in the same way that the arteries of the cerebral system participate in the sensibility and sympathies of the tissues to which they are destined. Still, however, the difference is very great; for the arteries of the external parts only receive very small nervous filaments, whilst those of the viscera are enveloped in large cords which seem to supply them with an additional coat. This arrangement appears to me a very wise one; for if the nerves of the arteries, and of the locomotive apparatus, &c. had been as considerable as those of the visceral arteries, they would have communicated to them too much sensibility; but as this property is very obscure in the visceral nerves, these may abound in the tunics of their arteries without rendering them too susceptible of lively sensations.

Be this as it may, we see from the above observation, that the arteries cannot be entirely strangers to the sympathetic phenomena, which may take place in the tissues to which they carry blood.

If, on the other hand, we reflect that the veins and lymphatic vessels,—in a word, the entire centripetal vascular apparatus, does not receive any cords from the great sympathetic, we must admit,

that the arterial or centrifugal vessels have a vital action somewhat different. But is it then impossible to explain this difference? I do not know that this question has been ever deeply examined, and it is that which induces me to engage in it.

The middle coat of the arteries, which is composed of circular yellow elastic fibre, is one of the strongest tissues in the body. Vested with the office of resisting the impetus of the column of blood which the heart at each instant propels into the vessels, and of reacting against this fluid, it has, I should think, need of a considerable nervous influx; for I cannot believe that it only owes its resistance and power of reaction to purely physical elasticity. I imagine, that, analogous to the muscles by its structure and composition, it ought like them to participate in innervation, and that such is the end for which nature has placed it in communication with the torrent of nervous influx, or, if you will, of vital electricity, which incessantly circulates in the living body. I propose this explanation until a better be found. Experimenters may perhaps confirm or refute it, by destroying the nerves which envelope the arteries. No doubt that, deprived of their plexus, these vessels would undergo some changes, were it only by the loss of a physical support so powerful as this kind of nervous sheath. But who knows what would be observed? We ought at the same time to destroy the nerves of relation that go to the arteries of the limbs, and which, much less numerous than the visceral ones, cannot be regarded as fit to furnish them with a coat for reinforcement; we should then see whether both sets would inflame, dilate, or contract. I am not aware that such experiments have been attempted; if any are on record, the learned will not fail to make us acquainted with them, and perhaps science will thereby gain something.

Whence comes it that the arteries placed in a part inflamed are enlarged, acquire more thickness and force in their tunics, and give more energetic pulsations, during the whole period of a phlegmasia, and resume their ordinary movements when it is dissipated? Does not this fact, which cannot be attributed to the impulsion of the heart, seem to prove that the arteries participate in all the irritations of the organs in which they are situated, and that consequently they receive their share of the innervation? And can we conceive of their having such relations, without admitting the nerves to be the means? Do we not also see the arteries of a part, which receives the sympathetic influence of a phlogosed tissue, more or less remote, become developed under the irritation of this latter? Does

not this sympathy, which I call organic, seem to prove that the arteries communicate irritation reciprocally to each other? And ought we to seek for the cause of this reciprocal influence elsewhere, than in the nerves that penetrate and form around them an uninterrupted chain from the heart to the point where these vessels are lost in the animal matter which is not vascular?

The great sympathetic nerve continues through the ganglions.—Do these small reddish parenchymæ secrete a fluid destined to traverse the nervous cords, as means of sensation and movement, or as nutritive matter? Have they rather the office of interrupting and altering the innervation coming from the brain, or directed towards it? Are they centres in which first converge, for the purpose of being afterwards reflected from one viscus to another, independently of the brain, the irritations which traverse the splanchnic nerves? These are questions not resolvable by direct experiment; they are only more or less probable. Still, however, their obscurity does not seem to me to interdict all general explanations of the functions of the great sympathetic. I believe that we may succeed by suitable reasoning, especially in employing the method of exclusion, to assign to it an order of relations which cannot depend on the cerebral nerves. I will endeavour to do this, in taking as a basis what has been said of the different cords of the splanchnic.

The great sympathetic or trisplanchnic nerve, is, as these terms indicate, charged with the office of associating the viscera of the three great cavities with each other. It has been said to preside over nutrition: this proposition merits an explanation. It is not by giving to the tissues the faculty of assimilating, of transforming the fluid animal matter in the secretors, of applying it to the tissues and solidifying it, nor by expelling the molecules which can no longer constitute a part of them, that this nerve presides over the internal life. These operations are of another order; they belong to the primitive vital power, and form a part of that vital chemistry, which is not this power but its first sign and effect. So truly is it this power which itself forms and supports the great sympathetic, that it would be absurd to attribute to this nerve, that by which itself exists; besides, comparative anatomy proves that this power has no need of this nervous ministry, since life is evident in its phenomena of composition, decomposition, &c. in the zoophytes which are destitue of nerves; and since the parts of animals furnished with nerves, which do not receive cords of the great sym-

pathetic, such as the limbs, do not the less enjoy life. It is then as regulator of the movements destined to send the fluid animal matter to the tissues which are to make use of it, that the great sympathetic presides over nutrition; and this function is participated in by the cerebral nerves. Let us give more developement to this last proposition.

The encephalic nerves establish relations with external bodies, and preside over the grander movements, as those of the muscular masses for locomotion. The great sympathetic establishes, in the interior of the body, relations between the viscera, and regulates their particular movements. For the exercise of this function, it borrows stimulation from the encephalon, and transmits some to it at need. Let us prove this by some details.

The great sympathetic receives stimulation from the cerebral nerves, which are themselves indebted for it to the action of external bodies, and make use of it to bring into play the cephalo-splanchnic and splanchnic muscles, and the coats of the arteries.—As it is not subject to intermission of action, it does not allow it in these two last orders of tissues, in which it is predominant. It tolerates it in the cephalo-splanchnic muscles, because the cerebral nerves are there in union with it; but it forces them to action when the wants of the viscera, of which it is the prime minister, imperiously require it. The muscles which do not receive cords from the trisplanchnic are the only ones that can enjoy a complete repose; and during this state they, together with the other tissues that surround them, have no other movements,—except those of circulation, which come from the heart, and consequently of the great sympathetic; they have, I say, no other movements but those of exhalation, absorption, composition, and decomposition, which depend either on contractility or vital chemistry, and by no means on the nerve of which we are now treating. It is then always the action of the muscles, including the heart, that it renders permanent in the viscera. If it suffered them to rest, life could not subsist, notwithstanding the continuance of contractility and vital chemistry, because the materials could no longer be subjected to this latter.

On the other hand, the great sympathetic receives the stimulation of the tissues in which it is found, and transmits it to the encephalon, by the cerebral nerves, with which it is in contact. For example, there supervenes in a point of these tissues, vital erections, such as exaltation of muscular movement, or a local ex-

aggeration of capillary circulation, of the transformation of free matter, of calorification, &c. Again, the great sympathetic gives rise in the encephalon to another stimulation, tending to provoke movements necessary for the restoration of the deranged equilibrium. More frequently these local irritations of the tissues placed in the domain of the great sympathetic, are not accompanied by pain; but that does not prevent the nerve from obtaining from the brain the necessary acts. At other times pain or pleasure is experienced; then the great sympathetic acts with still more energy on the brain, and more efficaciously forces the will.

It will be seen, that I here indicate the phenomena of instinct. It is thus that the wants, which all depend on an irritation of a viscus with vital erection, and that local irritations, when becoming causes of hysteric and epileptic fits, &c. act on the encephalon; and assuredly, if the irritated tissues had no other means of communication than the nerves of relation to make themselves obeyed by this apparatus, they would not succeed in a constant manner, the will preserving the power of resisting them: consequently, each time that nature desires to oblige the encephalon to make the locomotive apparatus act, it must avail of the agency of these same splanchnic nerves, which are never at rest, and which thereby become the preservers of life.

Not only can the nerves of the great sympathetic make the brain execute certain muscular movements, but they likewise determine a mode of action which produces a determined series of ideas, and thus make the judgment as well as the will incline favourably to the exercise of the functions. It is by this influence that they cause a liking or hatred for external objects, and even the same ones alternately, according to the mode of irritation prevailing in the tissues in which they predominate, at the moment when the cerebral nerves transmit to them the impressions which these objects have made on the surfaces of relation. I expressed this fact in a general manner, when, in the history of the phenomena of relation, I said that the centre of perception did not judge of the impressions of external bodies until after having obtained the advice of the viscera. As to the causes of the difference of these advices, they are nothing more than the external relations established in nature among the bodies which compose it; relations which, as I have said, take place long before man, the only being that can perceive them, has any consciousness of their existence.

When the organic irritations of the viscera are intense and obsti-

nate, the centre of perception is so modified by the splanchnic nerves which transmit them, that reason is lost and the man becomes insane. I have given examples enough of this to dispense with my recurring to them. If it be objected that the brain is then always diseased, I reply, that it is only so by the irritation that it receives from the nerves; an irritation which, during a certain time, may yield together with that of the visceral tissues that produced it, but which, at the expiration of this period, always difficult to fix, becomes idiopathic in the encephalon, and then often incurable. These facts, though well attested, do not prevent insanity from depending on a primitive irritation of this organ; for there is no tissue in the animal economy which may not be both primitively and secondarily irritated.

The functions which we have hitherto assigned to the great sympathetic, are then, 1. to subtract irritation from the brain for the use of the muscles which are in the service of the viscera; 2. to transmit to this organ the irritation of the viscera, in order to obtain the movements necessary for the gratification of their wants; 3. to render the muscular movements of the viscera independent of the will. Let us next inquire whether sleep be a necessary consequence of this triple action.

If the great sympathetic has the privilege of setting bounds to the exhaustion of vital powers or the means of action in the animal economy, whenever such exhaustions would compromise the integrity of the functions, it must be vested with the office of bringing on sleep. Now, have we not seen, 1. That this nerve obliges the will to leave the cephalo-splanchnic muscles at the disposal of the viscera? 2. That it forced the judgment to consider in a determinate manner the external objects necessary for the performance of the visceral functions? 3. That it determined as well the cessation of the acts indispensable to the gratification of the wants, as the performance of these same acts? Since, then, it can cause the individual to cease from the prehension of aliment when the appetite is satiated, and from exercise when fatigue is produced, why may it not cause sleep? It will, perhaps, be replied, that the feeling of fatigue which follows too long-continued muscular action, is a phenomenon of relation;—granted: but fatigue is followed by cerebral engorgement; and this latter I attribute to the great sympathetic, because it depends on a modification of the viscera. In fact, this modification acknowledges as a cause the painful sensation of fatigue; now, this sensation is reflected, like all the others, into the

viscera; the great sympathetic is, of course, affected; it reacts then on the brain, and to its influence is owing the engorgement of this organ, which produces the impossibility of innervation of the locomotive muscles, and finally sleep.

What, indeed, could limit this extravagant exhaustion of the powers of life, if there did not supervene a modification of the brain, which should render it impossible? And how conceive this modification to be different from that which obliges the brain to suspend muscular action, when exacted to do so by other wants; that is to say, how conceive it independent of the great sympathetic?

In the instances of excessive irritation of the encephalon, it will be objected, that the want of sleep is not felt; such as in arachnites, insanities, violent fits of passion, &c. It is because the great sympathetic has then lost its influence. But why has it lost it, if not because the encephalon has abstracted from it the degree of action which it ought to have? Here the natural order is manifestly inverted; but on reflection we shall find, that this state of exasperated watching would be habitual, if there did not exist some very potent power to prevent it. What could, without that, determine man to renounce the enjoyment of the waking state, which the cerebral nerves, much more sensible than the great sympathetic, render so lively and seducing? Would it be reason? This, alas! is too powerless: he should always, then, have recourse to the aid of education and reasoning to determine him to take repose. Nature could not place reliance on such means: besides, animals which are deprived of reason are still under the dominion of sleep. I think, then, that in place of weakening our proposition, the wakefulness of which I spoke only serves to corroborate it, and proves, manifestly, that a great power is required to circumscribe vital action in limits necessary to its preservation: this power, in my opinion, can only be confided to the nervous apparatus, that is to say, the great sympathetic, which, in other circumstances, is manifestly intrusted with regulating the action of the viscera.

I have reasserted, that the immobility necessary for sleep was the product of cerebral engorgement: would it be going too far to attribute it to the cords of the great sympathetic, which penetrate the cerebral substance with the arteries? It seems to me, that these nerves, taking on at this time excess of action, must draw the blood towards the capillaries of the brain; and from this congestion results at the same time the repose of the locomotive muscles, and

the augmented action of the orbicularis of the eyelids, the office of which is to withdraw the eye from the stimulating impression of the light. One would be at first tempted to believe, that all the other cephalo-splanchnic muscles undergo at the same time a diminution of energy; but, when we reflect that the lungs are engorged together with the encephalon, we are inclined to admit that all the visceral arteries which are furnished with ganglionic cords might very well participate in the modification of those of the brain; in which case we must explain the great efforts of the inspiratory muscles, manifest in the first moments of sleep, by the compression of the bronchial vessels, produced by sanguineous congestion, which diminishes the respiratory surface, and necessitates on the part of the brain an increase of innervation of the muscles. Notwithstanding this observation, I still continue in the belief, that the assimilating power is not augmented in sleep, because experience does not seem to me to warrant it. The partisans of the opposite opinion may say, that, if the blood abounds in the viscera during sleep, it ought to aid vital chemistry; but I would reply to them, that assimilation being always in a direct ratio to the waste, it cannot but lose its energy in a state which, like that of sleep, singularly diminishes the loss of substance in the animal economy. Be this as it may, I examine facts with the intention of throwing light on obscure points in physiology; and whatever be the opinion which my readers may adopt, I shall always be flattered at having furnished them with the means of arriving at the truth, even though their conclusions should be at variance with my own. We must ever distinguish the probable from the demonstrated; but I still think that the study of the former ought not to be neglected, since it may lead, and has led, in fact, frequently to the latter.

I have also said, in the study of the functions of relation, that the kind of engorgement or turgescence of the brain and other viscera, which brings on sleep, was accompanied by a sensation of languor, the pleasure of which is not well appreciated until the want of sleep has been opposed. It is referred to the muscles, and to the locomotive apparatus; but I think that it is sympathetic, and that it has its true seat in the engorged viscera, and above all in the encephalon, and the sub-diaphragmatic region, in which are found the most voluminous plexuses and ganglions of the great sympathetic.

Here, then, are the functions of the three orders of cords of this important nerve, explained at the same time with those of the entire nerve: 1. the cords of the cephalo-splanchnic muscles withdraw

these latter from the will, to make them obedient to the viscera; 2. the visceral cords regulate the movements of the heart, and the muscular parietes of the hollow viscera; 3. the vascular cords give power to the arteries, and invite more or less blood into their ramifications, according as the functions require it. By their presence in all the visceral arteries, they explain the redness of the tongue, eyes, &c. consecutive on gastritis; the injection and heat of the skin of the trunk which covers the inflamed viscera; the augmentation of the secretion of bile, and of saliva, in gastritis and inflammation of the gums, &c.: and by them we have accounted for sleep. In fine, the union or entire series of these nerves, as a result of what has been advanced, 1. establishes the independence of the internal movements as regards the will; 2. forces the brain to lend its action to the viscera; 3. to receive from these latter the excess of irritation which torments them; and 4. to suspend the exhaustion of vital powers, so soon as it is converted to the detriment of the individual.

The nerves of relation perform in the tissues to which they alone are distributed, as in the limbs, the same functions with the great sympathetic in the viscera. I mean to say, that they associate the muscles with each other, and with the brain, and establish sympathies among the arteries, considered in their reciprocal relations, and in those that unite them to the tissues into which they enter. But these nerves are different from the splanchnic in being able to bring the muscles into action only by the consent of the will; and whenever they establish sympathies between the arteries and the tissues, the brain is apprised of it by pain. Finally, when irritation is raised in these parts, to the extent of forcing the will, it is on account of its being very painful; and then, as it is reflected by the brain into the viscera, we must needs believe that the great sympathetic lends its influence to obtain this result.*

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* The reader who is desirous of further details and speculations on the subject of the sympathetic nerve, will be gratified by an attentive perusal of a review in the *North American Medical and Surgical Journal*, for April, 1831,—entitled "Anatomy and Physiology of the Ganglionic System."—Trans.

CHAPTER III.

OF RESPIRATION.

This is one of the principal functions of the living body; its object is to furnish the animal with the oxygen of the air, of which it is continually in want. In the lowest order of animals, the exterior of the body is sufficient for this vital process; it is perforated with numerous openings which are the mouths of so many canals called tracheæ, by which the air is introduced down to the interior of the vessels. Fishes are provided with a membranous apparatus, supported by cartilages having a parallel arrangement, and which are called gills. It is situated at the basis of the cranium, and is covered with moveable opercula which the fish raise at will, in order to place the water in apposition with their gills, and especially with their mucous membrane, by which the air contained in the water is absorbed, or the oxygen gas extracted by the decomposition of this fluid. But all these are cold-blooded animals. When nature designs the blood to be warm, she first places the circulatory apparatus in the interior of the body. But even that is not sufficient; for some of the reptiles, as the batrachia, the lungs of which are internal, are likewise cold-blooded; this comes from their respiratory surface, though internal, having but little extent, being limited to some vesicles, and receiving few sanguineous vessels. It is not so with warm-blooded animals; their respiratory surface is not only placed in the centre of the body, but is also of such great extent as perhaps to surpass that of all the other membranes, and it is, moreover traversed by the entire mass of the blood. It was then necessary that it should be folded on itself, as we find in the membrane of the digestive tube, and in the cerebral expansions which are folded and reflected on the same plan. Let us see how the Author of nature has proceeded in his supreme wisdom, to make the extent of the respiratory membrane consistent with the limited size of man.

Section I.—*A summary Description of the Respiratory Apparatus.*

The lungs which constitute the principal portion of this apparatus, fill almost the entire cavity of the thorax, the form of which

necessarily determines theirs; they appear to us as two irregular cones, the summit of which is placed beneath the clavicles and scapula, and the base, rounded off at the expense of its inferior surface, rests upon the diaphragm. A space is contrived on the left side to make room for the heart; hence the lobe on this side is divided into two lobuli, whilst that on the right presents three.—These lobuli are separated by transverse fissures, which do not penetrate to such a depth as to interrupt the continuity of the organ.

To have a physiological idea of the structure of the lungs, our attention must first be fixed on the trachea, to the inferior extremity of which they are attached like two berries on one stem.

The trachea, which forms the scaffolding of the lungs, may, with its bronchia, and their expansions, be considered as a hollow tree, the trunk of which, beginning at the larynx, terminates at the lower part of the neck, to be divided into two branches called bronchia. Each of these passes into one of the two thoracic cavities, and divides soon into branches, which are themselves subdivided into twigs, spread in every direction, and forming very delicate canals, which are terminated by small membranous cavities called *bronchial vesicles.* Such, if I may so express myself, is the frame work of the lungs; let us examine their structure.

The trachea is formed at its upper part, called larynx, of cartilaginous pieces, moveable on each other by means of small articular surfaces, and set in motion by a certain number of muscles; its upper opening, called *glottis*, corresponds to the posterior nares, and is capped by a cartilaginous piece, called *epiglottis,* which is always raised to give passage to the air, when a superior power does not determine its descent. In the remainder of its extent, the trachea is composed of cartilaginous circles, interrupted at the posterior part. A fibrous tissue furnished with muscular fibres, observed by the anatomist Reissessen, unites these cartilages that keep the trachea always open, and fills the interval which they leave on the posterior portion of this canal; it is this tissue which gives them mobility; it alone forms the bronchia, in which it becomes more elastic in order to keep the cavity always open, and supply the want of cartilaginous rings. This fibrous membrane is continued into the bronchial vesicles, where it still enjoys elasticity, and even contractility; but it would not be sufficient to keep them open, if the air that filled them were wanting, or if the surface of the lungs could forsake the parietes of the thorax.

The interior of the tracheo-bronchial tree is lined by a mem-

brane of relation of the mucous kind; it is continuous with that of the mouth; for the latter, after having lined the internal ear, the nasal fossæ, the canal of this name, and the oculo-palpebral surface, passes into the trunk to clothe the interior of the parietes of the respiratory and digestive organs.

It is around this hollow and complex tree that are grouped and distributed all the other tissues which constitute the lungs. The principal is the sanguineous vascular, which is double; for the bronchial tree receives for its nourishment, and the secretion of its mucus, arteries, that convey to it red blood; then come the pulmonary arteries, which, immediately after leaving the base of the right ventricle, penetrate into the parenchyma of the lungs, accompany the ramifications of the air cells, and, having become capillary, are so divided as to form a net-work around the bronchial vesicles. These capillary arteries then change into capillary veins, according to the opinion of some anatomists, and these again into veins of an always increasing calibre, ending at last in the trunks of the pulmonary veins, which deposit the blood that had, during this course, become red, in the left auricle, in order for it to penetrate into the ventricle of the same side, and to enter into the current of the aortic circulation.

To the vascular tissue is affixed, as an appendix, the lymphatic.—It is composed of ganglions, situated chiefly round the bronchial ramifications, and of lymphatic vessels, which, after having absorbed the fluids from all the surfaces, as also from the interior of the tissues of the lungs, go to the ganglions, traverse them, reunite, anastomose, become larger and less numerous, and finally terminate in the left subclavian vein.

The nervous tissue of the lungs is of two kinds in them, as in all the other viscera. The eighth pair, which descends from the cranium, furnishes first to the larynx of each side a branch, called *recurrent;* it then accompanies the trachea and the bronchia, to the membrane of both of which it is principally destined, but it gives branches to the cardiac pulmonic plexuses, which are in a great measure formed by the great sympathetic. This latter especially abounds round the pulmonary arteries, as well of dark as of red blood, and thus forms the second order of the nervous apparatus of the lungs. (M)

All these tissues are united and joined together, and, it may be said, separated from each other, by the cellular, which fills up all the interstices between them. This tissue, the areolæ of which are

moistened by a lymphatic dew or vapour of the greatest tenuity, facilitates the movements of expansion and condensation, which are very considerable in the parenchyma of the lungs; and never does it contain fat; which proves, as thought by professor Beclard, that the cells secreting this fluid, have not the same organization with those destined for the lymphatic exhalation.

This complex apparatus is enclosed in a diaphanous membrane, of the class called *serous* by Bichat; it is, like the lobes of the lungs, double. We may represent it to ourselves as two sacs without openings, which are spread out on one side over the external surface of the lungs, and penetrate into the fissures, and on the other over the internal side of the thoracic cavity, comprising a portion of the diaphragm and of the pericardium. The apposition of each pleura to the root of the lungs, above and beneath these organs, leaves a space called the mediastinum, which contains cellular tissue, the origin of the bronchia, and a part of the large vessels of the thorax. The internal surface of these pleuras is throughout continuous; and the lymphatic vapour which it exhales facilitates the gliding of the lungs on the parietes in which they are enclosed.

Such are the lungs, the principal organ of the respiratory apparatus. The remainder of it is composed of bones, viz. the dorsal vertebræ, the ribs, and the sternum; next the intercostal and abdominal muscles and the diaphragm, the relations of which we have studied when designating them under the title of *cephalo-splanchnic*. Let us now examine the action of this complex apparatus, which plays so important a part in the preservation of the life of the individual.

Section II.—*Action of the Respiratory Apparatus in general.*

Three grand functions are performed by the respiratory apparatus; aeration of the blood, pulmonary exhalation, and the production of sounds; this last, modified by the intellect, produces in man speech, singing, laughing, &c.

The aeration of the blood, the first and most important of the three, is common to all animals furnished with a respiratory apparatus. Exhalation seems to be inseparable from it, and may be studied in a two-fold point of view; as a means of depuration, and as a channel for the elimination of superfluous serosity. Aeration and pulmonary exhalation belong to the internal functions. I shall here only examine the first, reserving the other for the his-

tory of the excretions which shall be compared with each other. Voice and speech belong to the functions of relation: they must then be the first treated of in this chapter, as being a continuation of the functions of relation, of which I have before spoken, and as modifications of the mechanism that presides over the aeration of the blood. Each of these functions may, by its lesion, become a cause of disease; but I shall restrict myself to speaking of the derangements of aeration and of the productions of sounds, for it seems to me, that the disorders of the pulmonary exhalation require to be treated of in connexion with those of the other excretions.

Section III.—*Of the Aeration of the Blood in the Lungs.*

If we desire to proceed methodically in this study, we must first fix our attention on the internal sense in which resides the demand for respiration; now this sense is placed in the tracheo-bronchial mucous membrane, and all the rest of the respiratory apparatus only acts in virtue of the impulsions coming from it. Let us develope this proposition.

Vainly would we refuse a determinate seat to the want to breathe, or vaguely locate it in the nervous apparatus or in the brain. It is the mucous surface which receives the air, decomposes, and absorbs it in whole or in part; it is it then which must apprize the centre of perception of the existence of the want, and excite the necessary movements to gratify it, in a manner similar to that in which the mucous surface of the stomach causes us to feel the want of aliment, the same surface of the large intestines the desire for defecation, that of the bladder the want of urinary excretion, that of the genital organs the want of coition, parturition, &c. A peculiar pain known by the term uneasiness, is the first signal of the want of air. This uneasiness is not slow in producing a general irritation of the viscera; and, as the nerves presiding over their action are most abundant in the epigastric region, in it does this irritation always acquire most intensity. Whatever be the reason of this fact, it is incontestible: for all persons who are tormented by dyspnœa refer their anguish to the epigastrium, as if the numerous ganglions there met with were the rendezvous of the painful sensations that assail it.

Section IV.—*Mechanism of Respiration, or the Aeration of the Blood.*

The desire to breathe produces an appeal to the brain by means of the eighth pair of nerves or the pneumo-gastric, (F) and the brain calls into action the inspiratory muscles destined to enlarge the cavity of the chest. We are told that the section of the nerves of the eighth pair, practised in the neck, does not prevent the dilatation of the chest; but it is well to remember that this nerve communicates with other cerebral ones. These communications take place in the first instance, in the cervical region; moreover there are found, in the pulmonic plexus, cords of the great sympathetic, and these are continuous with others that have connexion with the spinal marrow. It is then impossible to prevent the irritations developed in the sensitive expansions of the pneumo-gastric from reaching the brain.

The principal inspiratory muscles are the intercostals and serrati, which elevate the ribs, and the diaphragm which, by contracting, pushes down the abdominal viscera; hence the expansion of the pectoral cavity. Whilst this is going on, the abdominal muscles are in a state of inaction, in order that they may not be opposed to the depression of the viscera in their cavity. It is sufficient that one of the two movements above indicated takes place, to produce this enlargement; and instinct chooses one or the other, or avails of both, according to the state of the muscles which are to act, or the viscera which are to undergo frictions during inspiration. Thus, if the intercostals, or the lungs of one side, are painful, instinct leaves them at rest, and is content to act on the opposite side. If both are in a state of suffering, instinct only calls into play the diaphragm. If this muscle, and the pleura and the peritoneum which line it, the stomach, liver, &c. cannot be moved without causing pain, instinct forcibly raises the superior ribs; finally, if inflammation has excited the sensibility of all these parts, as well as of the abdominal muscles, the dilatation of the chest is imperfect, and accompanied with the greatest anguish, both on account of the pain of the affected parts, and of the incompleteness of the aeration.

The expansion of the thoracic cavity leads to the supposition, that a fluid may penetrate into the bronchia and bronchial cells; this fluid is ordinarily the air. If the body were plunged into a liquid of greater density, such as water, this would be introduced

to the respiratory surfaces, as happens in submersion; but aeration would not take place.

The larynx, trachea, bronchia, and their vesicles, are then purely passive in inspiration; they allow themselves to be penetrated or distended by air, which thus enlarges the parenchyma of the lungs, and obliges it to follow the osseous and muscular case in its recession. So soon as the inspiratory muscles have acted, they are relaxed, and the abdominal ones, which are their antagonists, and consequently expiratory, depress the costal apparatus, and thrust up the viscera of the abdomen under the diaphragm, which, in its turn, is relaxed and rises into the cavity of the chest: after this, all the respiratory muscles are at rest, until a new sensation of the want of air determines the encephalon to put them into action. But let us examine into what takes place in the pulmonary parenchyma during inspiration. At the same time that the thoracic cavity is diminished, the lungs are necessarily condensed; and this must be accomplished in a regular and uniform manner;—we are then obliged to admit that all the bronchial vesicles are endowed with a contractile power, in virtue of which each of them retires on itself, expelling at the same time a part of its contained air: I say a part, for they cannot be entirely emptied. The retraction of the thoracic parietes is, in fact, limited by the bones which form its basis. So soon as this has reached its limits, the pulmonary vesicles cease to contract, for the very simple reason that the parenchyma cannot leave the parietes of the chest; this is the only cause of the limited condensation of the vesicles. If, consequently, there be little blood in the lungs, the vesicles are much distended after expiration; whilst, on the other hand, they would contract to the extent of being almost entirely emptied, if the lungs were in a decidedly plethoric state, as happens when this viscus is inflamed, or whenever, by an obstacle to the course of the blood, this fluid is retained in abundance in their tissue. On such occasions, the desire to breathe will be renewed, and we shall find instinct multiply the efforts of the common inspiratory muscles, and associate with them those of the muscles of the arm, scapula, neck, and head, which have a point of insertion on the cavity of the thorax. We see then that the quantity of air found in the pulmonary parenchyma is always in an inverse ratio to that of the blood traversing it, or of the fluids effused in the two cavities of the pleura.

SECTION V.—*Modifications of the Mechanism of Respiration.*

These consist in voice and speech, singing, sighs and sobs, laughing, coughing, and sneezing. The time to treat of these phenomena is when we have before us the regular movements of respiration, or normal respiration.

Voice, speech, singing, and hissing, are modifications of expiration. In place of the air issuing out freely, we retain it in the larynx, compress it, force it to vibrate the different pieces composing the larynx, which are then more or less tense, constricted or enlarged, by the divers actions of the muscles of this small apparatus: in the mouth, the expired air by means of volition undergoes like modifications, and we cause it to be driven out in varying volume, with more or less slowness or rapidity, in order to pronounce letters, and syllables: this is the result of education. Physiologists have at present nearly a complete knowledge of the mechanism of the production of sounds. It has been proved that the voice is formed in the space comprised between the thyro-arytenoid ligaments and the glottis. If we make an opening in the trachea, or in the crico-thyroidean membrane, the voice is lost, and, if this opening be obliterated, it is restored. An incision made between the thyroid and the os hyoideus does not destroy it. The section of the summits of the arytenoids allows it to remain, while a more profound lesion abolishes it. It equally ceases after a longitudinal opening is made. Finally, if we blow with force into the trachea of a dead subject, and contract at the same time the opening of the glottis, a sound similar to that of an animal is produced. It has also been shown that the larynx cannot be exactly compared either to a stringed or to a wind instrument, with or without reeds. The experiments of M. Magendie have proved that grave sounds are produced by vibrations through the whole extent of the thyro-arytenoid ligaments, and acute by the vibrations of their posterior part alone. It is also ascertained that the widening or narrowing of the larynx, its elongation or its shortening, contributes to render the voice either acute or grave. For farther details, I must refer to the works of Bichat and of Magendie, and to the articles *Voix et Parole*, in the *Dictionnaire des Sciences Médicales*, where the reader will find a summary of all that has been written on this subject.

Laughing, sighing and sobbing, have been studied in the history of the functions of relation, as means of expressing the passions by

which we are affected. It is here sufficient to say that they are either inspirations or expirations, more or less profound, quick or slow, regular or interrupted, always depending on the sensations that may be experienced in the different viscera, and which more or less influence respiration.

Coughing and sneezing, are always caused by a primary or sympathetic irritation of the mucous surfaces traversed by the air in the act of respiration. The first is solicited by an irritation which has its seat in the tracheo-bronchial membrane. Instinct, which takes perception of it, causes the abdominal muscles to contract; then the air expressed from the pulmonary vesicles swells the bronchia and trachea; the opening of the larynx is relaxed: the imprisoned air escapes with noise, in making the entire tracheo-bronchial tree to vibrate, and brings with it mucosities and other foreign bodies, which by their presence had incommoded the surface of the respiratory sense. Such is the usual object of coughing; but, as any irritation of this surface may produce it, expectoration is not a constant effect. The cough being a stronger expiration than ordinary, tends to produce a void in the vesicles of the parenchyma; hence, when it is violent and frequent, the person thus affected hastens to renew the supply of air to the lungs, by means of a hurried and very deep inspiration, accompanied by a peculiar noise. This is what we observe in hooping cough, a kind of bronchitis accompanied by a very lively irritation, that solicits multiplied fits of coughing, without giving the patient an opportunity of exercising inspiration, which only takes place at last when the abdominal muscles have thrust up as high as possible the diaphragm into the chest, and when the lungs are almost entirely exhausted of air. We may conceive that the want of this fluid being then sensibly felt, instinct must hasten to perform inspiration; and this fact tends to confirm the opinion which we before announced, that the movements of inspiration are the effect of a want that has its seat in the mucous membrane of the pulmonary apparatus.

Sneezing differs from coughing, in the irritation that solicits the convulsive expiration being in the nasal fossæ. In order to its ceasing, and for the expulsion of the foreign bodies which provoke it, instinct begins by filling the lungs with air, by means of a deep inspiration; then the abdominal muscles contract, the viscera which they raise up press the diaphragm into the chest, and the air is accumulated in the bronchia and trachea: but in place of issuing out by the mouth as in coughing, it escapes by the nasal fossæ; because,

at the moment of its arrival in the pharynx, the lower jaw is pressed against the upper, the contraction of the pillars of the velum palati raises the tongue, presses it against the palatine arch, and excludes the passage of the air through the mouth. If this last part of the process does not take place, the air escapes by the mouth, and in place of sneezing there is a cough; but this latter being more violent than common, there ensues a more considerable void in the lungs, which is always followed by a very painful sensation. We observe, that the mechanism of sneezing concurs with that of coughing in exhibiting the seat and nature of the want which presides over the movements of respiration.

As instinct has for its object always to ward off suffering, if any of the muscles which ought to contract, or if any point of the surfaces which are to undergo friction, are painful, coughing and sneezing, though solicited by the irritation of the bronchial mucous membrane, are incompletely performed, or even are not at all so. We observe this in pleurisy, pericarditis, peritonitis, and even in the highest grade of gastritis. The patient, at such times, is in a state of painful agitation or anguish; and, in the opinion of the vulgar, he has not strength enough to expectorate. Extreme emaciation also is opposed to the action of coughing and sneezing, because the mass of the abdominal viscera is too small to push up the diaphragm and produce fits of expectoration. Hence, we often see the phthisical, in the last degree of marasmus, lose the power of expectorating, and suffocated by the accumulation of pus and mucus in the pulmonary cavities. We may from this judge, how dangerous it is for a man reduced by a disease to contract a cough, and to be under the necessity of expectorating or performing deglutition so imperfectly as to introduce drinks into the trachea. We ought in consequence, scrupulously to abstain from making the asphyxied and the moribund drink, as they have no longer the power of performing deglutition with regularity.

Section VI.—*Of Aeration in particular.*

The atmospherical air, having been introduced into the bronchial vesicles by means of the muscles, the performers of all the grand movements, it is decomposed by a vital operation, which can only be referred to vital chemistry. Before its introduction, it was composed of nearly 21 parts of oxygen and 79 of azote in a hundred, with a small quantity, an atom in measure, of carbonic acid. After

its expulsion, it presents of oxygen 18 to 19 per cent. and carbonic acid 2 or 3 per cent. It has then lost as much oxygen as it has acquired carbonic acid, while traversing the pulmonary cavities. It is, thence, with reason inferred, that the oxygen of which the air has been deprived combines with the dark blood returned by the vena cava; and this loss of oxygen takes place without any disengagement of caloric capable of injuring the integrity of the tissues. The carbonic acid which the air gained after its coming out from the vesicles, could only have been furnished at the expense of the carbon which abounds in the blood of the pulmonary veins, and from which it derives its dark colour. This carbon is exhaled by expiration, and the blood immediately resumes the vermilion colour which it had lost in the aortic circulation; this is, indeed, a true depuration. It remains for us to know to what extent the inspired air, after its entrance, contributes to this,—a point upon which chemists are not agreed: some will have it that the carbonic acid is formed in the act of respiration; others, that the oxygen is absorbed by the pulmonary veins, and only joined to the carbon in the course of the circulation; for, say they, the sudden formation of carbonic acid at the moment of respiration would produce too great a disengagement of caloric. Besides, it is not proved that the air expired is always that which was just before inspired, since there remains between each breathing, in the vesicles, during a space of time much longer than that required for a respiratory movement, a certain quantity that could by absorption have been deprived of its oxygen, and be emitted to give place to that which has just entered.(N)

As to the vaporised serosity which escapes with the expired air, there is no need of supposing that the water, which is its base, is formed of the oxygen of the air suddenly united to the hydrogen of the blood in the act of respiration, since the same exhalation is observed on all the surfaces of the human body. Such a combustion would, moreover, most probably disengage more caloric than could be tolerated, without danger, by the delicate tissues in which is performed the aeration of venous blood; and there would result an expense of oxygen much greater than what actually takes place in respiration. After all, nature has, for all these combinations, peculiar procedures, which it is impossible for us to imitate.

The aeration of the blood, while it renders it of a vermilion colour, more coagulable, less serous, and less carbonised, confers on it also a more irritating property, and makes it fit for the exercise

of the various functions. It is thus that this fluid acquires the faculty of disengaging caloric, while furnishing the materials for all the combinations that are performed in the interior of the tissues, during the round of the circulation,—combinations to which we must add the formation of carbonic acid, if it takes place in the circulation at the expense of the oxygen absorbed in the lungs.

These facts are generally admitted as so many deductions, drawn by analogy from what takes place in chemical changes in inorganic bodies. In fact we see caloric disengaged whenever condensations or crystallizations take place, and even when new combinations or deviations arise, numerous in proportion to the differences always met with in the mixture of many bodies united in the liquid and molecular state, under the influence of atmospheric air. Now the condensations and junctions of divers molecules in a liquid state, take place in a constant and uninterrupted manner, in physiological phenomena: it is not then astonishing, that caloric should be continually disengaged by the exercise of the functions; and most reasonably are these phenomena referred to a chemical power peculiar to living bodies.

The vital principle which directs this living chemistry keeps the temperature of the body within certain limits; if it employ solidification, and the changes of form in animal matter, to produce this temperature, it also avails of vaporisation to prevent its rising to a height that would be hurtful to the integrity of the tissues, or destroy that condition of the fluids necessary to the exercise of the functions; and this again is an additional analogy to what we observe in the chemical changes in inert bodies. Accordingly, if the atmosphere in which man is placed be below the temperature of his body, his internal functions go on with redoubled energy; and as more combinations are necessary, more aliments are required, and nutrition becomes more active. If, on the contrary, the air be found warmer than the body, the skin supplies a greater evaporation, the fluids which would have yielded to combinations of too multiplied a character, are exhaled, the body is dried, and loses of its volume.

We may, I think, admit, as a thing well proved from all these circumstances, that one of the chief purposes of respiration is to furnish the animal with the means of creating for itself a fitting temperature; we see, in consequence, that animals with well deloped lungs in the interior of their bodies, are the only ones not torpid during the winter; and in this they are distinguished from the inferior classes, which perish or fall into a languid state

during that season. The first are called *warm-blooded*, the latter *cold-blooded* animals. Some with lungs in their interior, sleep during the winter; they form an intermediate class; and their sleep can only be attributed to diminished energy of the respiratory function. I am aware, that the experiments of Brodie seem to throw a doubt over the calorifying effects of respiration, for he found that though this process was kept up artificially, and the air blown in lost as much oxygen, and gained as much carbonic acid, in decapitated animals as in natural respiration, yet their bodies continued losing their heat. He has even observed, that the dead body became cold in a shorter time than another animal dead at the same time, but on which artificial respiration had not been practised; and he hence concludes, that respiration had rather for its object the cooling than the heating of the animal economy: but I am of opinion, with Thompson, that a comparison of the different animals completely destroys the force of this assertion, and shows us that the inherent temperature augments constantly with the increase in the size of the lungs. I believe that we may treat this question in the following manner.*

The embryo obtains its temperature from its mother, and during gestation nature is occupied in creating for it the organs which are to preserve it after its birth. So soon as it sees the light, its organs enter into action; but as they are yet weak, and as the skin has not the necessary degree of vigour and firmness for resisting the influence of too cold an air, which might subtract too much caloric from the young being, the mother is still required to furnish it with a part of her own. Finally, when the body has acquired more vigour, and the skin more firmness, the animal is enabled to take care of itself; its lungs supply it with an abundant source of heat, of which the circulation disengages a sufficient supply from all its organs; and the skin is in possession of the necessary vigour, either to prevent an excessive waste of caloric, or to deny passage to that from without, which might be capable of disturbing the

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* From the numerous and diversified experiments of Dr. Edwards we learn, in confirmation of the opinion advanced in the text, that the energy of respiration corresponds with that of calorification—both these functions being greater in warm than in cold-blooded animals, in the adult than in the young, and in winter than in summer. Birds, for example, uniformly consumed oxygen with more rapidity in winter than in summer. Hybernating animals, if roused from their state of torpor by mechanical irritation, so that the respiratory apparatus is brought into action, undergo a very considerable elevation of temperature.—Trans.

equilibrium required for the preservation of existence. After all, however, limits are placed to the exercise of this double faculty, for the excess of heat destroys us as well as the excess of cold; but we only sink under them after all possible reaction of the animal economy has been manifested, in which respect there are very great differences.

Muscular contractility seems to be in a direct ratio to the fulness of respiration; but it is more especially the nervous system, which gains most in activity by the increase of temperature; and we find augmented in the same proportion the ability to bear violent and continued exercises. This is observable in birds, the muscular power of which is greater than in other animals, for they can indulge in rapid and singularly prolonged movements, without their experiencing fatigue. We likewise remark, that they require for renewing their strength but a very light sleep, during which even they are subjected to very considerable muscular efforts.

We may, I think, deduce from all these facts, that the brain of man must be supplied with warm and oxygenated blood, for the enjoyment of energy requisite to the exercise of his intellectual functions. As to the passions, it seems to us demonstrated that they are always in direct ratio to the heat of the blood, on which also depends the degree of necessary action in the different viscera, so that these may respond to the impressions communicated to them by the encephalon, when it is engaged in ideas suitable to originate emotions. It is likewise very evident, that viscera animated by warm blood, will send to the centre of perception stimulations more acute, and more capable of influencing the turn of thought, than viscera chilled with a lymphatic and imperfectly oxygenated blood: all the phlegmasiæ attest this truth. It is not long since I saw a patient, who felt his ideas disturbed, and anger always on the point of breaking out, when his stomach was heated by stimulating drugs, and who regained his calmness and freedom of judgment so soon as he made use of cooling articles. Pythagoras made a similar observation, when he recommended to his disciples abstinence from animal food, in order that they might be freed from brutal passions, and give themselves up without obstacle to the study of wisdom and the practice of virtue.

We learn now what a number of physiological phenomena are connected with respiration. The aeration of the blood is the first and most important of the internal functions; that, the interruption of which can be the least tolerated, and on which so many evils

follow; hence the pulmonary phlegmasiæ are the most formidable of all inflammations. I now propose inquiring into the manner in which the various actions of the respiratory apparatus may become the cause of these diseases, as also into the other lesions of which it is susceptible.

Section VII.—*In what manner the Mechanism of Respiration may become the Cause of Diseases.*

So long as inspiration and expiration are regular, they cannot give rise to any pathological condition. There are then but the modifications of these movements, which are capable of producing it: now these are to be found, as we have seen, in the voice, speech, singing, laughing, sighs, sobs, coughing, and sneezing.—Voice and speech irritate the trachea and the larynx, by causing them to vibrate too frequently; whence results at times inflammation of these parts. This morbid state may take place in the mucous membrane, which becomes parched by the frequent passage of the air in too dense a column; but the muscles of the pharynx, the small articulations of the cartilages, and the fibrous tissue of the tracheo-bronchial canal, may also take on inflammation. There is nothing easier of removal than these diseases in their incipient state; but too frequently no attention is paid to them, they are allowed to make progress, and then become the cause of fatal disorganizations; hence laryngeal phthises, which are converted into pulmonary ones.

Speaking and singing also fatigue the larynx and the velum palati, and thus become frequently causes of angina, when there is an inflammatory action present.

Laughing and sobbing are less irritating to the air passages, than to the substance of the lungs themselves; they as well as forced cries and efforts of singing, retain the blood in them, and lay the foundation for pulmonary congestions and hæmorrhages. These modifications of the respiratory process act likewise on the heart, irritate, and may consecutively phlogose and dilate it. The convulsions of laughing and of sobbing, may become excessive and habitual, and be converted into diseases; they drive the blood towards the head, which may hence suffer from congestions, phlegmasiæ, ruptures of the vessels, and sanguineous exhalations.

Coughing and sneezing jar very much the trachea, and render it painful; but their most remarkable effect is, by creating a vacuum

in the pulmonary vesicles, to cause an afflux of mucus and even of blood, and to engorge and inflame them, so as to require new efforts, by which the tickling that provokes these convulsive expirations is still more increased: hence we cannot too frequently counsel patients affected with pulmonary catarrh to restrain the inclination to cough, and only to yield to it when they feel distinctly the necessity of expelling the mucus accumulated in the bronchial cavities, and that the expectoration will be easy. The congestive and phlogosing effects of coughing, are shown in a very evident manner in certain gastrites, which provoke sympathetically the desire to cough, without there existing any bronchial inflammation or the least mucus to be expectorated. We see only at first short fits of coughing without excretions, corresponding to the epochs in which the stomach is stimulated by ingesta, and removed at will by taking some demulcent. But if this precaution be neglected, the cough, by dint of being repeated, produces an inflammatory fluxion in the bronchial vesicles; chronic pneumonia comes on, and soon predominates over the gastritis. It is now more than eight years since I pointed out, both in my lectures and clinic, this kind of phthisis consecutive to gastritis; which, unhappily, is but too frequent.

We have said that sneezing expels a larger quantity of air from the lungs than coughing. We believe that the afflux of blood and mucosities to the bronchial cavities and the vesicles thus produced, is the principal cause of the propagation of catarrh from the nasal fossæ into the lungs. Sneezing is not less irritating to the nasal fossæ; the more it is yielded to, the more is the feeling which provokes it exasperated, and the greater the fulness of the fossæ; cerebral congestion is also a consequence of it, and more than one apoplexy may be referred to this origin. One of my pupils has lately acquired a sudden reputation, in his part of the country, for the cure of a sneezing, which was very harassing to the head, nasal fossæ, and lungs, and which, untractable to all the antispasmodics, was cured by an application of leeches round the nose.

Cough also irritates the diaphragm and the abdominal muscles. I have often seen, in cold weather, when pulmonary catarrhs were epidemic among the soldiers, the recti muscles of the abdomen, (sterno-pubien,) become excessively painful at their superior extremities, and inflamed, and present, after death, collections of pus in their fibrous tissues. I have even seen the inflammation extend in some subjects to the peritoneum; so true is it, that the cough may, from a symptom, as it was in the beginning, become a very dan-

gerous malady. Every practitioner knows that it may be also rendered convulsive, and kept up by the mere force of imagination, so soon as the patients think of it, or if those who are present recal it to their minds. I have had under my care a person, who, after having coughed in an extraordinary manner, was freed from this inconvenience by strictly attending to himself, agreeable to my express recommendation. But the fear of being again seized by it was so great, that so soon as I inquired of him after his cough, he replied to me by coughing, though he had not previously done so during the whole day. This inclination gained such an ascendency, that whenever he was apprised of my arrival, or recognised the noise of my gig at his door, he had fits of coughing. He was cured by the administration of narcotics.

It is needless to add, that coughing and sneezing may be a cause of hernia, and cause the rupture of aneurisms of the larger vessels.

Section VIII.—*Diseases resulting from Derangements in the Aeration of the Blood in the Lungs.*

The air that serves for respiration may be the bearer of hurtful particles or of irritating vapours, which will give origin to inflammation in the air cells and cavities. Mineral vapours, chlorine, ammonia, acids, such as the sulphurous in a state of expansion, irritating powders, as those arising in the pulverization of tobacco, euphorbium, squills, &c. frequently produce coryzas and pulmonary catarrhs. I have seen pericarditis evidently produced by the powder, on a man who worked in a manufactory of tobacco. Different smokes act also on the mucous membrane of the bronchia; and finally, the mildest odours, such as those of flowers, are at times sufficient to occasion coryzas and bronchitis. I have seen the emanations from cherries, exposed for drying, produce during the night such a constriction in the bronchial apparatus, that a violent fit of asthma was the consequence, which, at first, came on during sleep, like a night-mare, and terminated in a catarrh of some days duration.

All foreign bodies, of which atmospherical air is often the vehicle, may, by irritating and filling the air cells, impede the aeration of the blood, and bring on asphyxias, succeeded by inflammations of the tracheo-bronchial surface, which are sometimes very difficult to remove. When the inspired air is deprived of its oxygen, the aeration of the blood does not take place. At this time a gas more or less inimical to life, and not atmospherical air, is introduced into

the lungs. Among these gases there are some which are injurious only by the want of oxygen; such are azote and its protoxide, pure hydrogen, oxide of carbon, and carbonic acid without mixture. There only results from them an asphyxia without inflammation; but there are many others, which, by their poisonous nature, strike directly at the nervous system, and thus produce real poisoning. Of this number are, sulphuretted, phosphuretted, and arseniated hydrogen; the vapours of the hydrocyanic (prussic) acid, and the miasmata which arise from animal and vegetable matters in a state of putrefaction. These gases are endowed with activity so great, as to be capable of producing instant death,—a result only explained by the rapidity with which they penetrate through the whole extent of the nervous system, by the aid of the caloric that holds them in solution. When they do not produce this effect, they at least suspend respiration and circulation, and all signs of life. Those sufferers, whom the speedy application of oxygen has restored to existence, experience for a length of time weakness and uneasiness, and often retain, for a longer or shorter period, a phlegmasia of the mucous membrane of the respiratory passages. In all gaseous asphyxias, the decarbonization of the blood is interrupted; this fluid remains black, watery, and not coagulable; the transformations by vital chemistry do not take place; caloric ceases to be disengaged in the viscera; nervous irritability no longer gives any evidence of its existence, and muscular contractility seems abolished. Then all is thrown into a fatal repose. The aptitude of animal matter, to resume the vital condition, may sometimes still persist for a certain period, and it is for art to avail of it by applying oxygen gas, and rousing nervous excitability; but if this period, which is always short, be not turned to account, the repose of asphyxia is only interrupted by the internal movements of putrid decomposition, furnishing the certainty of death.

Are the aerial influences that cause these phenomena purely sedative? We are allowed to doubt it; for whenever the agents of which I am now treating act on the body in smaller doses, the phenomena of life are exalted and doubled in the tissues which they have modified, and some of the numerous shades of inflammation are manifested.*

* We cannot, I think, otherwise explain the etiology of malignant pustules, carbuncles, and even of typhus by infection, of which gastro-enteritis exhibits the essential characters, notwithstanding all that to this day has been said to the contrary. I have

It is thus that the system of warm-blooded animals resists cold, or the subtraction of organic heat; which would seem to show that irritation is the fundamental phenomenon of pathology, at least in those animals the study of which enters into the present subject.

Oxygen, that aliment indispensable to life, may in its turn become a poison. If this gas be in excess in the air in which we breathe, it irritates the vesicles and the entire pulmonary apparatus; it accelerates excessively the circulation, inflames the tissues, and gives rise to fever. Hence, the pure and cold air of elevated places, which we know to be abundantly charged with this principle, hurries the progress of chronic inflammations that tend to disorganization of the lungs. With still more certainty is the pure oxygen gas, prepared by artificial means, fatal to persons attacked with these phlegmasiæ. When the lungs act with too much frequency and energy, the blood is deteriorated by an excess of decarbonization. That which is drawn from the veins is then almost as vermilion as that furnished by the arteries; hence depraved secretions, and the body rapidly runs into marasmus. Pathologists ought to try and distinguish, in the diseases of the lungs, those which diminish the decarbonization from others which render it more active than natural. Such a discovery would doubtless enrich the therapeutical treatment of these diseases, and might throw light on the means of preventing them, as well as on the treatment of some others. I have remarked that very extended bronchitis occupying all the ramifications of the bronchia in the two lungs, and furnishing a puriform secretion, (such as bronchitis in measles,) keeps up constantly a livid colour, analogous to that of typhus, and gives a dark blood on venesection; whilst pneumonia, circumscribed in a small point, and, above all, at the summit of one of the lobes, as also incipient pleurisies, produce a roseate colour, and give a vermilion blood by phlebotomy. On this account blood-letting ought to be cautiously used in the former case, especially when the disease is of some days duration, if we do not wish to expose the patient to the risk of sudden death. In fact, though the emission of blood be still necessary at this epoch, it ought only to be local and drawn in small quantities. But in pleurisies, and in

long suspected that this phlegmasia, by reacting on the mucous membrane of the pulmonary apparatus, impedes to a certain extent the aeration of the blood, and that this is the chief cause of the lividness observed in the worst grade of those diseases. I would call the attention of inquirers to this important point of pathology.

pneumonias of limited extent, which leave intact the greater portion of the bronchial tree, bleeding, to be useful, must be copious, and often repeated,—for we find that the strength of the patient augments in proportion to the blood which he thus loses.

These facts, though anticipating pathology, do not seem by any means foreign to our subject, since they may aid in throwing some light on the first and most important of the internal functions, and on the etiology of the most common and depopulating diseases, at least in climates where the temperature is subject to frequent transitions from heat to cold, and from cold to heat.

CHAPTER IV.

APPENDIX—ON THE FUNCTIONS OF THE CEREBRUM AND CEREBELLUM, AS TENDING TO THROW LIGHT ON THE ACTION OF THE RESPIRATORY MUSCLES.

I HAD concluded the article on respiration before perusing the memoir of M. Coster, a physician of Turin, inserted in the first volume of the *Archives Générales de Médicine,* page 359, on the experiments of M. Rolando his countryman, and which have for object a clearer understanding of the functions of the cerebrum and cerebellum. M. Coster finds the closest resemblance between these experiments which were published in Piedmont in 1809, and those which were performed in France by M. Flourens in 1822.—The inferences from both are, that wounds of the cerebral hemispheres, in many warm-blooded animals, cause drowsiness, coma, loss of memory and attention, in a word of intelligence, without paralysing the locomotive muscles: the animal is as it were stupid; but if forced to do so, it walks, and evidently wants but volition to put its muscles in action. But if the cerebellum be wounded, convulsions supervene in the voluntary muscles of the opposite side; and if it be disorganized, or one of its lobes removed, that side is paralytic. The animal sees, hears, and so well understands the meaning of the menaces used towards it, that it wishes to retreat when afraid of being struck; but the muscles are disobedient to the order of volition. Still, however, in both cases respiration conti-

nues, ceasing only with life, and when the alteration has extended to the medulla oblongata.

The conclusions to be drawn from these facts are very evident and valuable to the physiological physician. They show that the hemispheres of the brain preside over thought, memory, will, and intellect; that the cerebellum is endowed with the function of calling into action the locomotive muscles; but that it cannot cause them to act in a regular manner, unless it receive the impulsion of the will, which in its turn exacts the integrity of the cerebrum.

Now since respiration is not interrupted either by the lesion of the hemispheres of the brain, or by that of the lobes of the cerebellum, it seems to me that this persistence must depend on the great sympathetic. I would view the question in this manner.

The centre of perception, residing, as I have said, at the summit of the medulla oblongata, is the point to which tend stimulations, in which reside perceptions, and whence emanate volitions. But we must distinguish volitions determined by the will from those governed by instinct; for the first suppose the integrity of structure and plenitude of vital action of the cerebral hemispheres, whilst the second suppose them as only occasional, and not constant. In fact, instinct is manifested by a great number of acts of various degrees of complexity. Those which are most so, such as the selection of food, and of the opposite sex, and the construction of a nest, the care of the young, &c., require that the hemispheres of the cerebrum, the seat of the intellectual faculties, and director of voluntary motion, should be susceptible of strong action, because here instinct cannot make itself obeyed without the intervention of these faculties. This is not the case with the acts of instinct of a more simple or less complex kind; such are respiration and the convulsive movements of the cephalo-splanchnic muscles. To execute these acts does not at all demand the direction of intelligence or volition, nor is the entireness of the hemispheres of the cerebrum necessary for this purpose. It is sufficient that the centre of perception exists, and that it can communicate with the muscles which are to be called into action: but this last is an essential condition; for if the medulla oblongata were separated from the spinal marrow by a section, there would no longer be any possible muscular movements of a general kind, but only partial convulsions, produced by the stimulation of each point of the cerebro-spinal apparatus, on which end the muscular nerves, either above or below the section,

or by the stimulation of the nervous trunk of a limb. Let us next inquire how all this is verified in the experiments of Rolando and Flourens.

When they had destroyed the hemispheres of the cerebrum, the centre of perception ceased to be in communication with the external senses, because these latter cannot operate on it without the concurrence of the action of the cerebral hemispheres, which are, as I have said, consulted by the intellectual part. The faculties of intelligence are therefore wanting, and stupor supervenes.

During all this time, however, respiration continues; because the impressions which come from the internal pulmonary sense, and which require the co-operation of the inspiratory muscles, arrive directly at the centre of volition, and have, to be obeyed, no need whatever of the concurrence of the cerebral hemispheres, the seat of intelligence. But from the instant when the instrument which disorganized the hemispheres, penetrates to the summit of the medulla oblongata, respiration and life cease, because the centre of perception and of volition has been destroyed. The same thing happens if the animal be abandoned to itself after the mutilation of its brain, because the inflammatory irritation will at the expiration of a certain time have penetrated to this same centre of perception and volition.

When the gentlemen experimenting wounded the cerebellum, the cerebrum being spared, they excited convulsive movements without injuring the intellectual functions; because they so contrived it, that a lively stimulation should be transmitted to the centre of perception, and act on it in an instinctive manner; but if, before any of the lobes of the cerebellum were interested, they had taken care to destroy its communications with the medulla oblongata, by dividing the pedunculi which pass to the pons varolii, I am persuaded that the cerebellar lobe might have been pricked and slashed without convulsion ensuing. What proves this, is the fact, that, when they entirely removed one of these lobes, paralysis of the voluntary muscles of the opposite side took place.

But whence comes it, that, during these two experiments, respiration still continued. Had not, then, the internal pulmonary sense any need of the cerebellum, to obtain the co-operation of the muscles dilating the chest, though they are in connexion with volition, and, as such, seem to owe their principle of action to the cerebellum? I think this new difficulty may be thus resolved.

The dilating muscles of the chest, or the cephalo-splanchnic ones,

are called into action by the centre of volition; but this centre makes them act under two different influences; at one time in obedience to the viscera, and at another under the subjection of the will. In the first case, it is stimulated from the internal visceral senses, and in the second, the stimulation is transmitted to it by the cerebrum and cerebellum. In other words, the centre of perception can only make these muscles act in obedience to the will, which is derived from the cerebrum, when the cerebellum furnishes it with the means; but it may, without the concurrence of either, put them in action, in order to their obeying the internal sense whence proceeds the want of respiration.

If it be demanded how I can know that the centre of perception, situated at the head of the medulla oblongata, is charged with such a function under this double influence, I reply, by comparing the experiments of Legallois with those of Rolando and Flourens. According to Legallois, the destruction of all that part above the point of insertion of the eighth pair, still allows respiration to go on; this act, then, has no occasion either for the cerebrum or cerebellum. On the same authority, the section of this medulla below the point mentioned, puts a stop to respiration; this point, then, must of necessity communicate with the dilating muscles, for the performance of respiration; and, in consequence, there are but two things required to support this function: 1. the communication of the centre of perception with the respiratory sense; 2. the communication of this point with the dilating muscles of the chest. If, now, we would reduce things to their true meaning, we shall find, that the experiments of Rolando and Flourens are fully confirmatory of those of Legallois; or rather, that they are the same in reference to respiration, since they prove what he had proved; 1. that the destruction of the cerebrum and cerebellum does not prevent respiration, provided the medulla oblongata be intact; 2. that the cerebrum and cerebellum cannot keep it up, if the medulla oblongata be destroyed. After all, these same dilating muscles which can contract to produce respiration, without the abovementioned parts of the encephalon, are dependent on them for the processes of speaking, and crying out, that is to say, they are obedient to the will. The medulla oblongata, then, their necessary motor, causes them to act under two influences which may be independent of each other.

It results, moreover, from this, if I be not deceived, that the intellectual faculties cannot produce voice and speech without the in-

struments of instinct, and that these latter may suffice for the instinct of respiration without the concurrence of the encephalic cerebral matter, destined to the phenomena of intellect. But we have seen above that this is not the case with all the instinctive acts, since many of them demand for their execution the encephalic instruments of mind. There exists, then, a series of instinctive acts, of which some require the co-operation of intellect, while others may dispense with it. But were I to enter into the developement of this series, I should only repeat what I have already said of the instinctive wants which the will can restrain, of those which it can only suspend, and of those, finally, over which it exerts no kind of control. I shall content myself, then, with referring to the first part of this work, still observing, that sufficient reasons for these differences are constantly found in the organization of animals.

I am next to consider the second proposition, which I have placed at the head of this appendix ; to wit, that the influence of the great sympathetic sufficiently explains how the respiratory movements still persist, even after the destruction of the cerebrum and cerebellum. The great sympathetic does not reach the medulla oblongata ; it is not then it which obliges the medullary point to support respiration, after the destruction of the cerebellum ; it only communicates with the eighth pair, and, consequently, on this latter does it act. Again, the great sympathetic communicates with all the nerves of the inspiratory muscles. It acts, therefore, in one direction, on the nerve in which resides the internal sense of respiration ; in the other, on the nerves of the muscles which the centre of perception causes to contract for the performance of this function. It has been imagined, that, communicating with the spinal marrow, it might derive from this latter the contractile impulsion for each of the inspiratory muscles. This proposition is inadmissible, because the section of the medulla oblongata, and even that of the spinal marrow, equally suspend respiration. In fact, if this communication had for its object the obtaining of contraction for the respiratory muscles in the entire extent of the trunk, we should find, after the section of the spinal marrow, the respiratory muscles situated below the point divided continue their action, notwithstanding the paralysis of the upper ones. Now this never takes place, and we thus obtain proof that the respiratory movements are called for by the respiratory sense at the upper portion of the medulla oblongata.

It is then a very certain, and well attested fact, that the communications of the great sympathetic with the eighth pair, and the muscles which perform respiration, are destined to transmit to the centre of perception the desire to breathe, and to make the viscera participate in the innervation that the centre throws into the muscles, at the moment in which it acts for the gratification of the desire.

From this association it happens, that the respiratory muscles may act independently of the influence of the cerebrum and cerebellum. Now there does not exist the like between the voluntary muscles and the great sympathetic ; this latter does not make any appeal to the centre in their favour ; and, on this account, these muscles cannot enter into contraction when the communication with the encephalon is cut off. Since the experiments of the vivisectors show that the destruction of the cerebellum produces a paralysis of these muscles, whilst it does not occasion that of the respiratory ones, we are bound to admit that this difference depends on these latter being maintained in action, by means of the union naturally established between their nerves and the cords of the great sympathetic. Thus the great sympathetic will have a double function ; first, that of soliciting the centre of perception to bring into action the respiratory muscles ; secondly, that of rendering them susceptible of obedience, notwithstanding the absolute deficiency of the influence of the cerebellum ; finally, there would remain to this latter the power of calling these muscles into play to satisfy the intellectual faculties, that is to say, the cerebrum or brain proper, whenever their action is not importunately solicited by the great sympathetic.

For the still better comprehension of this question, I will suppose that the great sympathetic is put in communication with the common voluntary muscles ; these would be, like the respiratory ones, obliged to gratify the wants of instinct ; and reciprocally, if it were necessary that a visceral muscle should become the agent of volition, nature would force it to this by distributing to it cerebral or spinal cords. I do not know whether comparative anatomy has realized the former of these suppositions ; but I know that it is in favour of the second, since the ruminating animals have the faculty of bringing up the aliment at will into their mouth, to make it undergo a second mastication.

How deny, after having meditated on these facts, that the great sympathetic is the organ destined to render the movements indispensable to life independent of the caprices of the will, and to act,

at the same time, as intermedial between the wants of vital chemistry and the organs charged with obtaining from without the agents necessary to the gratification of these wants?

Dr. Gall had invested the cerebellum with the function of reproduction. This assumption always seemed to me vague and unsatisfactory; I shall discuss it when treating of generation. For the present I will merely remark, after the learned professor Chaussier, to whom I recently communicated my doubts on this head, that one of the principal effects of the venereal orgasm is to determine a strong innervation on the locomotive muscular apparatus, and thus to produce an exhaustion which robust subjects bear better than feeble ones. If then it were proved, that the volume of the cerebellum is found in proportion to the muscular energy, what ought next to be ascertained, it would follow that, since athletic men are commonly most powerful in the generative act, the developement of the occipital protuberances should generally correspond to the excess of energy in the virile powers.

It must be an erroneous opinion, that the cerebellum is destined to preside over the movements of the heart, and other splanchnic viscera, as had been advanced by Willis. This function is devolved on the great sympathetic, which transmits to them, as we have shown, the stimulation of the encephalic apparatus, and which returns to the nerves of this latter, the exuberant irritation of these muscles, and that of the capillary system of the viscera, seized with inflammation.

Science advances uninterruptedly, and makes immense strides: two laborious experimenters, MM. Foville, and Pinel Grand-Champ, have just published an essay on the special seat of the different functions of the nervous system. The inferences from the pathological observations which they have collected, and the experiments which they have performed, are, 1. *that the brain is the seat of intellect and of motion;* 2. *that the corpus striatum and medullary fibres corresponding to this nervous mass, preside over the movements of the leg;* 3. *that the optic bed and the medullary fibres to which it corresponds, that is to say, those of the posterior lobe, keep under their dependence the movements of the arm;* 4. *that complete hemiplegia follows an injury simultaneously and equally affecting the parts presiding over the movements of the arm and of the leg; and that partial hemiplegia, or that which affects unequally the arm and the leg, depends on the alteration not being carried to the same extent in the*

optic bed and corpus striatum; 5. *that the cerebellum is the source of sensibility, and not, as M. Flourens supposes, the regulator of irritation.* These authors dwell also on the support given by the observations of La Peyronnie, who has seen affections of the cerebellum produce convulsions and a general exaltation of sensibility ; and they refer also to the opinions of Petit de Namur.*

MM. Foville, and Pinel Grand-Champ, have verified the experiments of M. Magendie, showing that the posterior roots of the spinal marrow preside over sensibility, and the anterior ones over muscular motion. They, in consequence, make the posterior medullary fibres descend from the restiform eminences which come from the cerebellum, and the anterior from the pyramidal and olivary bodies, which, in passing behind the pons varolii, are continuous with the white fibres of the optic beds, and the corpora striata.

Our experimenters have moreover thought they could remark, that in diseases of a purely mental character the alteration was

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* Dr. Gall has, we think with great reason, objected to the experiments of Flourens and other vivisectors on the cerebellum, and encephalon generally, that in their horizontal slices and sections, parts possessing very different functions, must be interested or destroyed at the same time. Remembering that one set of the intra-cephalic nervous fibres, radiate from the medulla oblongata on to the surface, and that another series converge to the corpus callosum and pons varolii, we can readily understand how ablation of a portion of the periphery shall affect the very centre of the encephalon, and of course, that the consequent phenomena give a very imperfect measure of the offices or functions of the portion removed. Our skepticism, founded on *a priori* or anatomical observation, in regard to the value of such experiments, is but too well justified in the conflicting results of the different vivisectors. Flourens is contradicted by Magendie, and Foville and Pinel Grand-Champ are in their turn opposed by the later experiments of Bouillaud, who made use of cauterisation to destroy the cerebellar lobes. This latter is, however, in accordance with Flourens, in regarding the cerebellum as the regulator of the associated movements which compose the acts of station and locomotion,—a power which is, he thinks, essentially distinct from that which governs the simple movements of the trunk of the body and the members, while there exists between these forces the most intimate connexion. According to Serres the median lobe of the cerebellum is the exciter of the generative organs. Its hemispheres are exciters of motion in the limbs, more especially the lower limbs. The cerebellum is, he thinks, the exciter of jumping. The tubercula quadrigemina are, on the same authority, exciters of associated voluntary motion, or equilibration ; and, moreover, exciters of the sense of sight, in the three inferior classes of animals. For a good summary of the present opinions and actual knowledge of this and other parts of the nervous system, we refer such of our readers as can conveniently obtain a perusal of it, to an inaugural thesis, " *On the Structure, Functions, and Diseases of the Nervous System*," by John R. W. Dunbar, M. D. Published by J. Dobson, Philadelphia, 1828.—Trans.

limited to the superficial gray substance of the hemispheres of the cerebrum.

Here then we have the seats of the intellectual faculties, of the movements of the limbs, and of sensibility, apparently determined: the cerebellum will therefore only act on the muscles as the exciter of pain. But there remain yet many facts to be established, and I cannot forbear proposing to the gentlemen vivisectors the following questions.

If it be true that the superficial gray substance of the hemispheres of the cerebrum, presides over the intellectual operations, how is it in correspondence with the nerves of the external and internal senses, by which are transmitted the impressions that call the intellect into action, since this gray substance is not continuous with the nerves? The impressions which feed the intellect being founded on the exercise of sensibility that resides in the cerebellum, how are they transmitted by this latter to the surface of the cerebrum? Would the white, which is adherent to the gray matter of the cerebral hemispheres, be alien to muscular motion, and serve rather as a means of communication between the cerebellum and cerebrum? Would the fibres of this white substance of the periphery of the cerebrum, thus form, with the gray substance adherent to them, the theatre of the intellectual operations and faculties—in confirmation of the system of Dr. Gall, who assigns to each of these faculties an organ susceptible of forming a prominence externally? Have these same white fibres of the periphery, which on this supposition would be destined to the intellectual operations, and those of the corpora striata and optic thalami, that regulate muscular motion, a point of union? And does this point exist in the medulla oblongata? What purpose is served by the gray matter placed between white fibres in the corpora striata, the beds of the optic nerves and the medulla oblongata? What is the office of that observed in the cerebellum and spinal marrow? Are there in those places mental or instinctive faculties, and, if not, has the gray substance any other appreciable function? What is the portion of the encephalic apparatus, which presides over the movements of the respiratory muscles?

The writers of whom I am now speaking consider the spinal marrow as only a fasciculus of nerves, establishing communications between the cerebrum or cerebellum, and the different parts of the body: by this hypothesis, how are we to explain the presence of the gray matter in this fasciculus, whilst we find none in the pe-

duncles of the cerebrum, or in those of the cerebellum? and why is not the whole dorsal medulla arranged like the lumbar, which is in fact but a fasciculus of nerves?

It had been before proposed to consider the gray substance as, above all others, the active part of the encephalic apparatus; which is equivalent in my mind, to calling it the seat of sensations and the point of departure for volitions. This opinion pleases me the more, as then the white fibres would be but the conductors of these phenomena. I had even compared, and the idea was frequently expressed in my lectures, the sensitive nervous expansions to this gray substance. I was tempted to regard these two vasculo-nervous forms of animal matter as the seats of sensations and volitions, and white fibres interposed between them as the means of communication from one to the other. I view this mechanism thus: the impressions would be made on the vasculo-nervous matter, forming the sensitive surfaces of the external senses, and of the mucous membranes; they would be transmitted by the white nervous fibres to the central vasculo-nervous matter, that is to say, to the gray substance of the medulla oblongata; and thence the volitions or innervations would set out, and, traversing the nerves in an inverse direction, would produce the phenomena of muscular movement. If this mechanism be admitted, it would be in perfect accordance with the experiments of our authors; for the stimulations received by the sensitive nerves, and thence passed to the gray substance of the medulla oblongata, might be sent, some to that of the cerebellum, where they would produce sensations of a certain kind; others to that of the hemispheres, where they would elicit thought, and whence they would be reflected into that of the corpora striata and thalami of the optic nerves, from which must emanate the movements for the voluntary muscles; some, in fine, would enter into the gray substance of the medulla oblongata only, in which would spring the volition to make the inspiratory muscles act, and perhaps many instinctive determinations. This mechanism would seem the more probable, because at this same point, that is to say, at this portion of the gray matter, the eighth pair, which brings to the encephalon all the stimulations of the viscera, abuts,—stimulations which are, as I have shown, the determining causes of the movements attributed to instinct.

But agreeably to this view of the subject, it would be indispensable for this said portion of the gray matter equally to receive volitions coming from all other analogous portions, comprising those

of the spinal marrow; for the cerebellum would in vain tend to produce pain, the hemispheres thought, the corpora striata and optic beds motion of the limbs; they could not succeed in accomplishing these things without the influence of the gray matter of the medulla oblongata. In this manner one might explain how it is the centre of perception, and the motor of all the volitions; how it is brought to act, at one time, by the aid of the gray matter of the hemispheres, which would preside over the intellect; at another, by that of the cerebellum in obedience to pain or pleasure; and again, by the stimulation of the viscera, which perhaps obtains a new degree of power while passing through the gray matter of this last mentioned organ. We might, on this showing, admit the opinion of the ancients, who thought that the cerebellum presided over the movements of the principal viscera, and that of Dr. Gall, who places the seat of concupiscence in this organ; since the venereal appetite forms an essential part of the phenomena of instinct. We also explain, how the will can arrest the effects of venereal desires, and those of pain and many other instinctive impulses, owing to the gray matter of the centre of perception being influenced by that which presides over the intellectual operations. Finally, the impossibility of long resisting the desire of respiration, vomiting, defecation, and discharge of the fœtus, may be attributed to the peculiar kind of stimulation which the eighth pair receives from the great sympathetic, and which it transmits to the central point that now engages our attention.

As it is impossible to believe that stimulations produced on any sensitive surface whatever, should be directed by a peculiar affinity, at one time, towards a certain portion of gray matter, and again towards another portion, I proposed, as has been seen, to admit, that, after having reached the central point of the medulla oblongata, they are all reflected and disseminated throughout the entire extent of the encephalic apparatus, and even the sensitive surfaces, internal as well as external; for I see no reason why these stimulations, these electric commotions, should stop at one point; but perceive many to induce a belief that they are general. It will then be conceived how they should assume different hues on returning to the central point of perception, after having traversed the divers departments of vasculo-nervous matter, as well intra as extra-cephalic, and how determine volitions in the sense required by the intellectual or instinctive wants of the animal.

The intra-cephalic vasculo-nervous matter, or the gray substance

of the encephalo-spinal apparatus, the extra-cephalic vasculo-nervous matter of the sensitive expansions, the intermedial white fibres to transmit the stimulations from all parts of the body towards the brain, and *vice versa;* such are the conditions which to me seem indispensable, for the exercise of the functions of the nervous system ; and hence the reason why I have asserted that the brain can never act alone in the most simple intellectual process, and even in the slightest sensation. All the morbid phenomena seem to me to corroborate this idea, the reasons for which will be more fully developed in my treatise on Pathology.

There arises, in this place, a very powerful objection against the opinion of those who assign separate nerves for sensation and motion. No doubt but the nerves which go to the sensitive surfaces, such as the skin, are more sensible than those which are distributed to the muscles, and other tissues not fulfilling sensitive functions in the natural state ; but, in numerous other cases, these latter become very much so ; it is sufficient for this purpose that they be modified by inflammation. It is thus that rheumatism renders muscular action very painful ; we know to what extent it becomes so in the phlegmasiæ of the spinal marrow ; and I have seen tremors and pains of the muscles occasioned by arachnitis. What is there more insensible than an articular surface in a state of health? What more sensible than the same surface in gout? Where is the sensibility of the pleura, the peritoneum, the arachnoid, in a person who is well? Does there exist more atrocious pains than those which are caused by inflammation of these membranes? How are we to believe that the nerves that preside over the functions of these tissues, in the normal or natural state, are not those which acquire this degree of perturbating sensibility. If the great sympathetic, the most obtuse of all the nerves, can acquire this property, is it possible to suppose that a single branch of the encephalo-spinal domain can be entirely alien to pain or pleasure?

There is then but a difference in degree in the sensibility of the nervous tissues ; they are all conductors of stimulations, and these latter are more or less felt, according to the necessities of the functions over which the nerves traversing them preside. All these isolations of vital properties are chimeras; there exists but one, the shades of which vary, though in their nature essentially identical ; and I challenge any other conception of physiology.

The brain cannot then be devoid of sensibility. That it has little in a normal state I concede; but what are we to think of those

violent cephalalgias which correspond so precisely to certain abscesses of the brain? Is it intended to make the cerebellum the seat of cephalalgias from gastric irritation? It will be found, we are told, in the arachnoid; granted: but why do not the nerves of this membrane make us feel any thing in the natural state? And are we to suppose the pains so deep and lancinating, with heaviness, fulness, and dizziness, felt in the hemispheres, to be in the cerebellum? The cerebrum is on the same footing with many other tissues: suddenly injured, it evidences no pain; but give it time to be inflamed, and you will see that it has likewise its sensibility. Is not the same remark made in reference to the liver, the substance of the lungs, and the globe of the eye? And if it be alleged that the brain has been seen inflamed and suppurated in consequence of wounds without causing pain, we would reply that this observation may be made of the other viscera. Sensibility exists every where in nervous and irritable constitutions; in subjects of an opposite nature it is obtuse in the parenchymæ of the viscera; in all it is exquisite on the sensitive surfaces. It is developed in the commencement of phlegmasiæ, but it is deadened often by the persistance of irritation; and this is one of the causes which have so long rendered inflammatory diseases misunderstood.

But whence comes it, we shall be asked, that wounds of the cerebellum so promptly excite pain and convulsions? This can result from no other cause than from its being destined to reflect irritation vividly into the nervous apparatus; that is to say, from its being a very active promoter of sympathies, and pre-eminently the exciter of important movements: this is what we learn from the experiments of MM. Foville and Pinel Grand-Champ. It is a great deal, I concede with the liveliest pleasure; but we must not thence conclude that it is the reservoir of sensibility, or that it alone presides over its evolution. I would prefer saying with Rolando and Flourens, that it is only the inciter to muscular movement: but both assertions are equally incorrect. The cause of sensibility is every where diffused, since contractility resides in all the tissues; but there are some of them, the function of which consists in collecting stimulations, (which are nothing else but the putting this property into action,) transmitting and reflecting them from one organ to another; and if, while these phenomena are going on, *the self* be attentive, there is sensibility; if it be absent, that is to say, if the centre of perception be not susceptible of acting, there is only a transmission of stimulations. Sensibility can then have no other

seat but the central point of the brain, where the stimulations terminate, nor any other condition than the possession of consciousness. *The self* perceives with more or less readiness pain in different organs, according to the state of their nerves; in the healthy condition, it refers this pain to the internal and external senses, because they are normal or standard centres for the reflection of stimulations, which the animal must necessarily receive, and because the vasculo-nervous matter is there found in a fitting state for this reflection; but if inflammation has prevailed some time in a tissue, until then insensible, it will create a new vasculo-nervous matter, a true accidental sense, to which the stimulations will tend, and in which pain will sometimes be more acutely felt than in the ordinary senses. A puncture of the cerebrum will not, we are told, cause either pain or convulsions, whilst that of the cerebellum largely produces such an effect. I do not doubt it, since it has been observed: but expose the cerebrum and spinal marrow of an animal affected with a violent arachnitis; exercise stimulation on them, and see if pain will not take place, and if the muscular apparatus will remain immobile during the operation. On the other hand, destroy the summit of the medulla oblongata; stimulate the cerebellum, and you can then judge whether this organ be the receptacle of sensibility. A magazine of sensibility, independent of the centre of perception and the existence of consciousness, seems to me chimerical. I may be deceived, but I require, in order to be freed from error, experiments other than those hitherto published on this point of physiology. To feel is to think, and sensibility is the *soul*.

CHAPTER V.

FUNCTION OF ASSIMILATION.

The assimilation of alible matters devolves on an apparatus of organs of great complexity, extending from the mouth to the anus. But as, when studying the sense of taste, we spoke of mastication and insalivation, we shall now only treat of deglutition and digestion. Deglutition is performed by the œsophagus: digestion takes place in the stomach and intestines, by the aid of certain fluids supplied from the glands annexed to these organs.

Section I.—*A summary Description of the Digestive Apparatus.*

The œsophagus, which forms the superior portion, establishes a communication between the mouth and stomach : it is a hollow cylinder, composed of a muscular tunic, which chiefly makes up its structure, since the principal function of the œsophagus is to carry along the alimentary mass ; and of an internal membrane, which is restricted to supplying a mucous liquid, fit to facilitate this progression. There is very little to be said respecting this canal, the sensibility of which is very obtuse in a normal state. Its superior part, called pharynx, presents, however, some interest to the physiologist : it is funnel-shaped ; its upper portion, which is the widest, corresponds to the base of the cranium, and forms the fauces : and the inferior portion, which is narrowed, is continuous with the œsophagus. The pharynx is formed of muscular bands, lined internally by a mucous membrane having papillæ communicating with the cerebral nerves, and in which to a certain extent is continued the sense of taste : the muscles of this funnel are in part voluntary. This region of the œsophageal canal is the only one which evinces any sympathy,—being closely united to the stomach by cords of the great sympathetic. We find consequently in it the phenomena of relation and nutrition, as we shall see when examining its physiological action.

The digestive canal, properly so called, begins at the superior orifice of the stomach, and terminates at the anus. It may be divided into three regions, the stomach, the small intestine, and the large intestine : these three regions have many characters in common ; but each of them has peculiar connexions and uses, which concur to the grand general function of digestion.

The entire digestive canal has a common character in being formed of three membranes ; one internal, of a mucous nature, which plays the principal functional part ; one middle, which belongs to the series of splanchnic muscles ; both of them are peculiar to the digestive tube : the third, which is external, is a portion of the peritoneum, that is to say, it is common to all the viscera and sides of the abdominal cavity. The mucous tissue of the digestive canal is not in my opinion purely gelatinous ; for we find in it nervous expansions, which, though blended with the capillary, sanguineous, and mucous systems, must present albuminous matter, similar to that of which the cerebral substance consists. The

dissection of this membrane is impracticable; we only know that it is vasculo-nervous, and that it exhibits follicles or glands, placed between it and the muscular coat, and destined to secrete the mucus, which penetrates through the membrane by means of small excretory ducts, and continually lubricates the interior of the digestive canal. Are there any other secretory organs in this tissue? This we shall inquire into when treating of that part constituting the gastric surface. The general mucous membrane which now engages our attention, evinces contractility, but in a very limited manner; it forms numerous folds and plaits, which are more or less completely effaced when the canal is distended. These are called *valvulæ conniventes.* The muscular plane is formed of fibrin, and its bands are separated by an areolar tissue, easily distinguishable in certain portions of the digestive canal. The fibres which compose it affect different directions, longitudinal and transverse; they are eminently contractile, and play a very important part in the functions of the alimentary canal. The muscular is closely united to the mucous membrane, by an areolar tissue, which never contains fat.

The serous membrane, which is external, is the only one of a homogeneous structure. We find in it gelatin alone; for the sanguiferous and lymphatic vessels which are seen in it, are themselves furnished by this substance.

The peritoneum supplying this membrane is detached from the abdominal parietes, in order to embrace the digestive canal by a fold that forms two laminæ, between which the canal is placed. It is strongly adherent to this latter through the greatest part of it, that is to say, at the anterior and posterior surfaces of the stomach, and at the anterior face only of the intestines; but in some parts it recedes, and then its only connexion is by means of a cellular tissue, in which may be deposited some fat. This arrangement is observable at the two curvatures of the stomach, and at the internal curvature only of the small intestines. The object of this is to facilitate the dilatation of the digestive canal, by permitting it to glide between the two laminæ of the peritoneum, and afterwards to resume its former dimensions.

It is between the duplicatures of the peritoneum that are placed the vessels and nerves which establish the communication between the digestive canal and the other organs, by conveying the materials of nutrition, and enabling it in its turn to transmit them to the body generally. The arteries come from the abdominal aorta, and as-

sume different names in their course, according to the region of the canal to which they are destined. The veins come from the capillary tissues, and all meet in a common trunk, usually called *vena portæ*, or, more correctly, *sub-hepatic vein*, which thence goes to the liver to deposit in it the blood collected in the intestinal canal. Two orders of lymphatics are found in the digestive apparatus ; one constitutes a part of the general lymphatic system ; the other which comes from the intestines has the name of *lacteal vessels:* all meet in a common trunk of which we shall speak hereafter.

The nerves are of two orders : one, coming from the eighth pair or pneumogastric, is of the encephalic domain ; the other is derived from the great sympathetic, a description of which has been already given. Each region of the digestive apparatus now requires a particular examination.

The stomach, which forms the most important portion, is placed in the epigastric region, above the other two, and beneath the diaphragm. It appears as a considerable expansion, constituting a kind of bag, with two openings, one of which corresponds to the œsophagus, and the other to the first of the small intestines. I shall be careful not to eke out the chapter by a detailed description of this organ, but content myself with designating what is important to be known, in order to have a just idea of its functions. I would mention then, that it is situated transversely, and curved on itself, forming an arch of a circle, directed from left to right, and from above downwards, to again rise, so that its two orifices are higher than its fundus : it is compared to a bag-pipe. It follows as a consequence from this, that the substances which it contains do not tend to escape by their own weight, though the right or pyloric orifice, which communicates with the intestines, be situated a little lower than the left or œsophageal opening. We must also note, that its smaller curvature, which is the upper one, and the greater, which is the lower, are abandoned by the peritoneum in such a manner as to leave a double triangular space occupied by a very lax adipose tissue, in which the stomach retreats when it is distended with food. We have already observed, that the small intestines only presented this disposition at their internal curvature, consequently the stomach has much more room than all the rest of the digestive canal to enlarge itself. We must, moreover, observe, that the muscular fibres of the stomach are stronger than those of the small intestines, and less so than those of the large ones ; that

they are most powerful at its two orifices; that in these parts the internal membrane is thicker, more sanguineous, and better furnished with mucous follicles; and that, much richer in vasculo-nervous expansions than that of the intestines, it is so in a much more positive manner at these orifices than in the rest of the organ. If then this membrane constitutes an internal sense, as we think we have proved, it must be conceded that it is more peculiarly so at the above orifices than elsewhere. Finally, I would remark, that the predominance of the sensibility of the stomach over the other regions of the digestive canal is due less to the great sympathetic, which, however, is met with in considerable proportion, than to the eighth pair, which furnishes to this viscus several branches, called stomachic cords, the like of which are not found in the intestines. It remains for us to know whether the portion of mucous membrane, belonging to the stomach, contains secretory organs, the office of which is to furnish a fluid fit to produce the assimilation of nutritive substances. The existence of this liquid has been admitted by some under the name of *gastric juice.* Others have denied it in the most formal manner, asserting that the serous, saline, limpid, and frothy fluid, which the human subject sometimes ejects by vomiting in the interval between the digestive efforts, can only be saliva, the deglutition of which went on in an insensible manner; or of pancreatic juice, which, by irritation of the stomach, has been drawn into its cavity. They also rely on the absence of every kind of glandular tissue, fit to furnish such a fluid. The question is as yet undecided; though, if we are to judge by analogy, we shall observe that many animals are provided with gastric glands, supplying a digestive liquid. We meet such in the succenturius of birds: the lamantin of the north, (*Manatus,* Cuv.) presents, in the coats of its stomach, a gland of very considerable size, devoted to this purpose. I would demand, in my turn, if it be not possible that the gastric fluid, which we consider as mucus, is a true digestive juice; and if, consequently, the glands that secrete it would not be different from those destined for genuine mucus? (O.)

The second region of the digestive canal has been divided into three sections: the *duodenum*, the *jejunum* and the *ileon.* I believe there are but two recognizable portions; the duodenum will form the first; all the remainder of the small intestines on to the ileo-cœcal valve, will constitute, in my mind, the second. In fact, the duodenal portion preserves something of the properties of the

stomach: it is wider, thicker, more muscular, nervous, and sensible, than all the remaining part. We see in it a curve analogous to that of the stomach, but directed from right to left, and, consequently, fitted somewhat to retard the passage of the alimentary substance; hence it has, from some anatomists, received the name of *small stomach.* It doubtless represents the second stomach of the non-ruminating herbivorous animals; but what particularly distinguishes it is the common orifice of the canals for bile and pancreatic juice, the secretors of which are placed near it, and with which it is associated by nervous cords and vessels.

Immediately at the termination of the duodenum, which is adherent throughout, thereby facilitating the temporary delay of the chyme, the small intestine becomes free and floating, in the midst of the grand central fold of the peritoneum, called *mesentery:* it is moveable, and much more narrow in its diameter than all the other regions of the alimentary canal. In this portion the mucous membrane has but a small supply of nerves, and little sensibility; it is porous, and absorbs, like a sponge, the chyle that it deposits in the numerous lacteal vessels of the mesentery, with which it communicates. The muscular coat is thinner, the intestinal cavity is here always empty, and numerous lacteal ganglions are placed between the laminæ of the corresponding portion of the mesentery. The very important remark may here be made, that the cords of the eighth pair do not seem to be prolonged into this region, which is, consequently, under the influence of the great sympathetic. The blood-vessels by which it is penetrated are numerous, though we meet with no other secretions but that of a mucus, which to a certain extent possesses, perhaps, an assimilating property. These characters, to us, seem sufficient to distinguish the small intestine from the others. After having described a number of convolutions, placed one above another, it terminates at the ileo-cœcal valve, a fresh narrowing, which offers great interest to the physiological physician, as we shall see when giving an account of the normal action of these organs.

The large intestine is separated from the inferior portion of the small one, called *ileon,* by this valve, which is simply a considerable fold of the internal membrane, the free border of which corresponds to the *cœcum,* a kind of enlargement or sac, whence begins the colon. The mucous membrane which forms the cœcal valve, is strengthened by a cellular tissue, numerous vessels, and a greater number of mucous follicles than are found in the adjacent parts.

We are also at liberty to suppose that the nervoso-vascular expansions are more considerable in it, since its sensibility is developed to a remarkable degree in the pathological state. It is equally a matter of observation, that the small lacteal glands or ganglions are very abundant in that portion of the mesentery, corresponding to the part in which the intestinal canal undergoes the transformation that now engages our attention. These remarks will be turned to a useful account in the pathology of intestinal phlegmasiæ.

The colon constitutes the major part of the large intestine. It begins in the right iliac region, at the pouch called *cœcum,* is directed upwards, passes before the kidney, is seen under the concave surface of the liver, traverses the epigastric region from right to left before the duodenum and pancreas and beneath the great curvature of the stomach, to which it is attached by a double fold of the peritoneum, that is subsequently extended to all the other intestines, and is the *great omentum;* thence the colon turns downwards, to be directed, while it passes by the side of the spleen and before the left kidney, to the iliac region of that side. At this place it forms a considerable fold of a curved form, which traverses the hypogastric region to return to the point where it set out. But whether it runs this course or not, it dips into the pelvis, and describes a straight line, assuming then the name of *rectum,* to finally terminate at the anus.

The form and structure of the large intestine differ from those of the small ones ; its mucous coat is thicker ; the muscular of that portion of it called colon, is composed of longitudinal fibres, which make up the major part of it, and of bands, some transverse, others longitudinal, which cross each other at right angles, with the effect of narrowing the diameter of this intestine, and of leaving in their intervals, and on its free surface, cells of various sizes. These are always most considerable at the middle or epigastric region, which bears the name of *arch of the colon;* they disappear in the lumbar regions, where the intestine is, as it were, plunged into the cellular tissue, behind the peritoneum, which is only here adherent to its anterior surface. This epigastric portion is then the most dilatable, and it is not rigidly embraced by the peritoneum ; the fold of this membrane, or the omentum which contains the intestine, as well as the stomach, abandons it at its superior and inferior surfaces, having the same relation to it as to this last mentioned viscus. Vessels and nerves placed in the cellular tissue of the omentum, are common to the stomach and transverse portion or arch of the colon.

It is important to bear in mind this arrangement, for the just appreciation of the connexions too little noticed by pathologists, which associate the stomach and middle region of the large intestine together. The lateral portions of the colon have communications, by nerves, with the kidneys, spleen, and spermatic vessels. The rectum is in the same manner connected, in man with the bladder, and in woman with the vagina.

We learn that the large intestine, partaking of the cerebral, spinal, and ganglial nerves of the duodenum, stomach, kidneys, bladder, and vagina, must be endowed with more sensibility than the floating portion of the small intestine, which only communicates with the brain by the small cords that connect the great sympathetic with that organ. This is what experience proves; as the kind of pain called *colic*, has almost always its seat in the colon, whence is derived the name.

It is observed that the muscular fibres of the rectum are very powerful; they communicate with those of the anus, which is more abundantly supplied with cerebral nerves; hence, in this point, the presence of fæces causes the irritation which is transmitted to the whole rectum in order to produce defecation.

We have yet to speak of the subsidiaries to the digestive tube; but as I must treat of them in the history of the secretions, I shall content myself with remarking, here, their relations to the gastro-intestinal mucous surface, on which their excretory ducts open.

Section II.—*Of the Functions of the Digestive Apparatus; Hunger—Thirst.*

We must again set out with the functions of relation, since hunger and thirst, the natural preludes to digestion, suppose a concurrence of action between the assimilating apparatus and the brain.

Natural hunger is founded on the want of nutritive materials; the exercise of the functions decomposes and dissipates the free and mobile animal matter; the fixed portion has no aliment for its reparation; there is no longer a sufficiency of stimulations appropriated to vital chemistry in the fluids; this process is deteriorated, and hence the source of the want. It is then that the portion of fixed matter, that is, the nervous form of this matter, which is destined to the functions of relation, undergoes a peculiar stimulation: in whatever manner this last may arise, it is not the less certain, that by the centre of perception it is always referred to

the stomach. This viscus seems therefore to be the point to which converge all the famelic stimulations resulting from the deficiency of nutritive materials in the different parts of the body. It is in a state which the centre of perception regards as painful, and which causes the desire of alimentation to be felt. Hence it is from the organ destined for the assimilation of the nutritive materials, that the sensation emanates, which determines the animal to seek them. Nothing is more certain ; for if the stomach be diseased, the necessity of nutrition, though carried to a very great degree, and well understood by the intellect, would not produce an instinctive want. In fact, this one, like all others of the same order, is founded on a peculiar visceral sensation. Now, when the stomach is inflamed, it is not the feeling of hunger which is felt, but others, which occasion sometimes thirst, sometimes a dread of all kinds of ingesta,—very often anger, almost always sadness ; or else these sensations give rise to stupor, delirium, convulsions, and even at times abolish the mental faculties, according to the mode and intensity of the irritation of the great sympathetic ; for we have shown elsewhere that to it alone belongs the power of overcoming the intellect and forcing the will.

We see that it is impossible not to attribute to this nerve the famelic stimulation of the stomach. It must bring it to this organ by means of its prolongations in the coats of the visceral arteries ; and when this stimulation has reached its tissue, it is diffused through all the plexuses of the abdomen where it is taken up by the extremities of the eighth pair, to be transmitted to the cerebral centre ; but this latter speedily reflects it into the nerves of its domain, and the intellect repels all other ideas, in order to be exclusively occupied with those relative to alimentation, whilst at the same time the entire muscular apparatus becomes painful, and loses a part of its energy.

These modifications in the phenomena of relation are soon accompanied by many others, observable in the play of the organic functions. The stomach being pre-eminently the stimulator of the whole economy, since it calls the brain into action for the seeking or avoiding of nutritive matters, the heart, and all the secretors in aid of assimilation, depuration, &c. must all fall into languor when it is no longer stimulated by the presence of aliments. Hence we find that the inertia of the heart is soon added to that of the brain and muscles, from which, as a necessary consequence, results slower respiration, coldness of the entire body, and especially of the skin,

diminution of all the secretions, a sensation of emptiness and lightness in the body, proceeding from the circumstance of absorption not being proportionate to the exhalation.

Such is the first period of hunger; but, if it be not appeased, another series of phenomena is not long in occurring. The painful sensation of the stomach is increased, and becomes a very powerful stimulus to those very organs which it had previously thrown into a state of languor; sadness is changed into anger, and the cerebral centre, tormented by the constantly increasing stimulation of the great sympathetic, repels every idea alien to the want, and reserves all the powers of the economy to execute the acts necessary for alimentation. As muscular action is its principal instrument, the muscles receive an abundant innervation; agility and force are displayed in the highest degree, especially in the carnivorous animals, from which often much exertion is required to procure their nourishment; the action of the heart and lungs is revived, the circulation accelerated in order to aid the locomotive apparatus, and anger exasperated by the continually increasing pain in the epigastrium, serves as a constant support to the general exaltation. What most struck an observer on the raft of the frigate *Medusa* after her shipwreck, was the scenes of fury and rage renewed every minute among unfortunate creatures abandoned in the midst of the ocean.

The sensation of thirst is not less terrible in its effects; it does not necessarily produce, like hunger, an inertia of the different functions, because it may be experienced by persons satiated with solid food. As it is more irritating, it occasions from the first an exaltation. Thirst, which is felt in the fauces and pharynx, consists in a sensation of dryness and heat, with a desire to drink; for its cause consists in a deficiency of fluid destined to moisten those parts. It soon extends to the œsophagus, seems to traverse the chest, which is represented as *all on fire*, and in fact the tracheo-bronchial mucous surface is parched and burning; this sensation of heat seems to be lost in the stomach. The portion of mucous membrane which is the seat of the feeling, is injected with blood, and deprived of serosity; it becomes burning and inflamed. The desire for fluids is exhibited with renewed force, and all the wishes of the sufferer are directed towards cold water.

When hunger lasts too long, it is necessarily joined with thirst, and this latter often becomes in the end predominant. These two wants combined are the torment of the unfortunate famished per-

son; but it is more especially the latter, which seems to us that which inspires the most ardent desires, and most excites to anger.

Hunger and thirst may be suspended by sleep; for so soon as consciousness disappears, sensibility is no longer manifested, though the irritations which give origin to it still persist. This fact in conjunction with a thousand others, proves that sensibility is by no means a vital property of the same order with contractility, and that it is only the consequence of the latter being called into action. I have elsewhere said that this result was not a phenomenon of matter, and is incomprehensible, for in my mind it is blended with thought. Yes, let us dare to repeat it, to feel is to think. I will even say expressly, what I had already indirectly advanced, to feel is to judge; and it is as ridiculous to make of sensibility an organic function, as to consider it a property inseparable from living animal matter. I repeat it once more, there is no other property but contractility dependent on organization, or if you will on the chemical composition of animal matter, and which varies according to this composition. The exaltation of this property, which is revived under the influence of stimuli, and which by the nerves is transmitted from one tissue to another, constitutes that stimulation which never ceases in the living body. Finally, when consciousness exists, and we are aware of this stimulation, there is sensibility, but this phenomenon is necessarily intermittent.* Any

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* An objection has been made to this assertion, which it is important to meet. It has been alleged in favour of an uninterrupted state of sensibility, that, since the fœtus moves in the uterus, it must necessarily have felt stimulations, which came from the viscera to its brain; only, it is added, its sensibility is more obtuse, and we are told that the person asleep is in the same condition. To this we may, it seems to me, thus reply. If you refer to sensibility all the movements that result from the stimulation of organized matter, you ought equally to attribute to the same cause, the motion of the leaves of the sensitive plant, since they also contract under the influence of a stimulation; then the movements of the stamina which stoop to embrace the pistils, the closing of the petals of the marygold during the night, the expansion of those of night-shade in the cool of the evening, will be likewise effects of sensibility, and this property will be found diffused through the whole vegetable kingdom. The name will even be conferred on the contraction of muscles separated from the living body, and on the movements of the excretory ducts in exciting their fluids. Sensibility not being appreciable, except by contractility, we should then be justifiable in laying aside this property, and in admitting but the first, or to attribute them both to each particle of animal matter. In fact we should say, *every fibre which moves by the contact of a stimulus, has felt; every fibre is then sensible:* it would afterwards remain for us to divide, as Bichat has done, sensibility, into animal or perceived, and organic or not perceived. But who does not see that there is here an abuse of the word sensibility?

other hypothesis is beyond my comprehension. We see, from what has been said, that if the necessity for aliments and drinks persists during sleep, the instinctive want does not exist, that is to say, is not known without consciousness. Even though aliments and drinks be necessary to the sustenance of a man sleeping profoundly, their deficiency is not attended with so much disturbance as in the waking state. The reason of this difference is, that the stimulations of the animal economy are greatly augmented in energy, when they are perceived by the sentient *I*. It moreover follows, that he who can sleep in spite of the wants by which he is agitated, suffers less than he who is deprived of this advantage. This fact confirms also another assertion which I advanced in the first part of this work, viz. that the state of sensibility is a violent one, which becomes a perturbator, and would tend to exhaust the powers of life if it were not interrupted by sleep, which for a time carries us back to the fœtal state.

We may now judge how important it is for the pathologist to be well acquainted with the functions of this digestive apparatus, which, as the principal exciter of the animal economy, exerts such an influence both in the sleeping and waking states.

Abnormal hunger and thirst will be treated of in the pathological part of the digestive function.

The word *organic sensibility* analysed, expresses the following fact: *the fibre of an organized being has contracted by having been touched by a foreign body.* The word *animal* sensibility expresses this other fact: *the animal has experienced pleasure or pain.* Now tell me, I beseech you, what is there in common in these two facts? The first is a phenomenon entirely material; the second is purely intellectual. For the first we require but a piece of organized matter; for the second we want an animal full of life, having a cerebral centre, and being in a waking state. If you place sensibility in the nerves, why not say that this property still exists in those of a limb separated from the trunk? It is sufficient that the nerves no longer communicate with the brain for it to disappear; that is to say, for the man having it no longer in his power to say, I suffer in this amputated limb when you prick it.* If you require this avowal, in order to the recognition of sensibility in an arm or in a leg, which you irritate, why will you admit its existence in the brain of a recent embryo, and in that of a dying apoplectic, whom you may prick and slash without their complaining? It is time for us to understand one another in physiology. Apply the term contractility to the movements of organized matter, and reserve that of sensibility for the phenomena of consciousness; the property entirely intellectual, will become the attribute and the proof of mind, and we shall no longer hear the ridiculous question proposed: *Are plants sensible?*

* If a man tell you, *I suffer in the limb which I no longer have*, it is because he experiences irritation in the extremities of the divided nerve, which are a part of his body; but this depends on a fact foreign to the question now under discussion, and which I shall treat of in another place.

SECTION III.—*Action of the Digestive Apparatus.—First Assimilation.*

The aliments having been cut by the incisor teeth, torn by the canine, and ground by the molars, to which they are presented in regular succession by the combined action of the tongue and buccal muscles; and having been, at the same time, penetrated by saliva and mucus, are united into a mass, called *alimentary bolus,* which is carried into the pharynx in the manner already indicated when treating of the sense of taste. The mucous membrane of the pharyngeal funnel is no sooner sensible of the presence of this bolus, than it determines the contraction of the muscular bands which are affixed to it. The action of these latter, which contract from above downwards, and from the circumference to the centre, agreeably to the direction of their fibres, engages the bolus in the œsophagus; and this latter, continuing to contract in the same manner, soon carries it into the cavity of the stomach. Let us cast a glance over the relations between these successive acts, and we shall find the manifest transition from the external life to that called *organic.*

The masticatory movements are determined by volition, in conformity with the impression made on the sense of taste, and transmitted by it to the cerebral centre. They may be suspended at will; but so soon as the bolus has passed the isthmus of the fauces, the portion of mucous membrane which then receives it has no longer need of the concurrence of volition to make the muscles of the pharynx act. This membrane calls on the brain for contraction; and the latter obeys, because invited to do so by the cords of the great sympathetic. Still, however, as cerebral nerves are met with in the pharynx, if the alimentary bolus excites pain, or if it pleases the will to refuse it a passage, the pharyngeal fibres contract from below upwards, and the bolus is propelled towards the cavity of the mouth. These muscles are to be placed then in the series of the cephalo-splanchnic ones.

The process is of a different nature so soon as it has passed below the pharyngeal funnel, and has reached the œsophagus properly so called; as in this place the sympathetic nerves predominate, the mucous membrane makes itself obeyed without any opposition from the will, and the bolus can no longer be arrested in its progress to the stomach.

If, however, its presence was inconvenient; if it was not sufficiently moistened by mucus; if it was stopped by asperities, as in

the case of its containing a bone or cartilage, a pin, &c. instinct will be stimulated for its expulsion by the œsophageal sense, which is of the number of the internal ones; it will excite hiccup, or even vomiting, and we shall then see the respiratory muscles, which are also cephalo-splanchnic ones, forced to suspend respiration in order to second the efforts of the splanchnic muscles of the stomach for the purpose of producing the ejection. By this mechanism, then, the will is forced, whilst in the mouth it cannot be so, however disagreeable the impression produced by aliments on the sense of taste. Thus, suppose that the will persists in having the unpleasant aliment masticated and swallowed, the sensation thence resulting may, when the substance reaches the base of the tongue and touches the velum palati, provoke efforts to vomit; but if the will persists the aliment will still be swallowed, unless vomiting be actually excited; for, as this movement resists volition, it will expel the aliment, together with the other substances rejected by the stomach. In these cases it is very evident that instinct has not forced the masticatory muscles to reject the aliment, but only obliged them to suspend their action, and to open the cavity of the mouth in order to facilitate vomiting. These muscles have then obeyed the visceral sensations, which draw after them the will, but were not at all subservient to the impression made on the sense of taste: this impression tends to solicit the will to reject the aliment, but it has not the power to force it; there must, for this purpose, always intervene a visceral irritation. The only local phenomena, which can be produced by the sensation of taste independent of the will, are the secretion of saliva, and that of mucus from the tonsils, as I have shown, when treating expressly on mastication. These views would seem to be in anticipation of the pathology of deglutition, but they were necessary for the understanding of the mechanism of this process.

The aliments and drinks having reached the stomach, remain in it a certain time, in order to be submitted to assimilation. The latter process belongs to vital chemistry; but while this power acts on them, it manifests phenomena of relation, the study of which is very important to the physiological physician. We will now take up the consideration of them.

The transformation of alimentary matter into chyme, is a process of vital chemistry, which is known, but not explained; whilst it is in our power to account for the phenomena of relation, that accompany it, by referring them to irritation. This latter remains inexplicable; but this is not now the question that engages us.

Is assimilation produced by the action of the mucous membrane, aided by fluids peculiar to the person in whom the process takes place, and the molecules of which are put in apposition with those of the *ingesta?* Is it accomplished by means of water, heat, and atmospherical gas? The reply to these questions can only be in the affirmative. The presence of air, the aid of heat and water, are by no means doubtful. The mixture of the ingesta with the humours of the subject is not any more equivocal, since they only reach the stomach after being impregnated with saliva and mucus. But one is desirous of knowing whether the stomach furnishes a peculiar fluid. We have expressed our opinion on this subject; but whether the gastric fluid possesses an assimilating property, which, for ourselves, we admit, without pretending to demonstrate its actual presence, or whether it does not possess this property. Still it is certain that the alimentary mass is mixed with a great quantity of fluids peculiar to the subject. These conditions being fulfilled, assimilation is performed. Neither contractility nor sensibility are its immediate agents; they only concur as instruments of relation. But we must distinguish organic relations which do not interest the encephalon, from those relations in which it participates. Let us begin with the first, which have the closest connexion with assimilation.

The gastric surface is irritable: stimulated by aliments, it furnishes them with fluids from its own tissue. It invites, also, those of the salivary glands, and of the liver; for the bile is not confined to a union with the chyme which traverses the duodenum; it is forced up into the gastric cavity, perhaps not for the digestion of all kinds of aliments, but certainly for that of some, as of fatty and oily substances. It comes in during the first period of digestion, and then imparts a bitter taste to the alimentary mass. We may even call to mind the circumstance of there being animals in which the biliary canal opens into the stomach. If the bile arrives at this viscus, it would seem to me probable, that the pancreatic fluid is likewise directed into it, and this without the necessity of any effort at vomiting, or even nausea.

The first part then, performed by contractility in digestion is, to oblige the auxiliaries of this process to furnish their fluids. The relations by which this afflux is determined are, as we know, performed at a short distance.

The second office of contractility is also very limited, and, like the first, is gone through without the aid of the encephalon. It

consists in placing the muscular coat of the stomach at the disposal of the mucous membrane, at first, for the retention of the alimentary mass, and afterwards to communicate to it very slow oscillatory movements, which tend to direct it from the cardia towards the pylorus, and from the pylorus towards the cardia. These movements are the consequences of the different direction of the fibres of the muscular coat, and are always in accordance with the manner in which the gastric sense is affected. We here suppose them to be in a natural state, because we are studying natural or normal digestion, in which the gastric sense is stimulated in a manner conformable with the wants of the economy. The contractions which we now describe, keep up, then, a movement of the alimentary mass, and present it successively to the different regions of the gastric cavity, by which its assimilation must be facilitated.

When the food has remained some time in the stomach, it is transformed into chyme; its bitterness has disappeared; it is acid, and of a peculiar acidity, and at length becomes fit to pass the pylorus; and then begins what is called second digestion. We will follow this process, before speaking of the relations in which the cerebral centre participates.

The ingesta do not always pass the pylorus at the same moment; those which require the least assimilation pass the first. Magendie has observed that water and alcohol are promptly disposed of; he thinks that the veins of the mucous coat of the stomach absorb it. This assertion does not seem to me sufficiently substantiated, at least in all cases; for in pyloric irritations, which cause a distention of the stomach, water, together with the food, is accumulated in the cavity of this viscus until vomiting comes on, and the urine is almost nothing. I have had several opportunities of assuring myself of this fact: and I am inclined to think, that if the water disappears so promptly from the stomach, it is rather because the pylorus lets it pass the first, than because it is entirely absorbed by the mucous membrane. It would be, however, hazardous to deny, that this absorption cannot take place to a certain extent; for I am persuaded, that there is no part of the living body which does not possess more or less an absorbing power.

Be this as it may, what we are very sure of is, that alimentary matters of a certain density, and which require a long digestive labour, are not absorbed by the gastric membranes, but are forced to remain on them for a certain time. When this period has expired, the pylorus, to which they had been many times presented,

allows them a passage, even though their assimilation should be incomplete, or should not have taken place. Experience proves this every day, since pieces of tendons, and of bones, and coins, finally pass into the intestines. I believe that these foreign bodies clear the pyloric strait by aid of substances in a more advanced state of assimilation: at times, however, they are inevitably thrown back, as we shall see in the pathological part of our subject. We find, from this, that the natural or normal evacuation of the stomach is commanded by the internal sense, which forces the muscular coat to be contracted in such a manner as to expel its contents, after having first obliged it to retain them during a certain time. This difference in the commands made on the muscular coat can only depend on the manner in which the sense is affected; and here we may distinguish two degrees of this affection; the first, which is the effect of the impression of aliments not assimilated, tends to retain them; the second, which results from the impression of aliments converted into chyme, tends to expel them through the pylorus. There is a third, which we shall find in the pathological part.

It was formerly thought that alimentary matters approaching the nearest to the nature of the individual, were the most promptly assimilated, and absorbed the first. Experience has not exactly responded to this theory. Dr. Sarlandière has ascertained, at the Hotel Dieu, on three persons having artificial anus, that food the least nutritive, such as the roots, stems, and leaves of vegetables, and fruits, arrived more speedily at the opening than farinaceous articles, milk and meat: the difference is even considerable; for in the space of an hour to an hour and a half or two hours, the first came away by the wound, without even presenting any great alteration; whilst the second appeared only at the expiration of three or four hours, under the appearance of chymous matter already perfectly elaborated. These experiments prove, that the internal gastric sense repels the aliments which offer the least assimilative matter, and retains, with a kind of complaisance, those from which it can derive better aid for nutrition. The physician whom I have just cited observes, that milk and fecula pass more promptly than meat, without their being, however, less assimilated, which gives to this kind of food a great advantage over any other, when it is required to nourish a person whose stomach is very irritable: still, however, idiosyncrasy may furnish exceptions to this rule.

Though the bile be directed, when required, into the stomach, it is not the less certain, that it is furnished with more abundance to the chymous matters during their short stay in the duodenum. All physiologists believe, that there then takes place a process by which the excrementitial matters are precipitated, and the chyle destined to be absorbed is separated from them: it is evident, that, at the expiration of natural digestion, the acidity disappears in the contents of the small intestines. The chyle, presenting the appearance of a milky liquor, is carried to the circumference of the mass moving through the intestines, and is directed towards the mucous membrane, to which it seems to adhere. This membrane absorbs it like a kind of sponge, and causes it to reach the chylous veins, commonly called *lacteal vessels*, in which we shall take it up, when treating of secondary assimilation.

After having traversed the long channel of the intestines, the product of digestion approaches the ileo-cœcal valve; this point of narrowing retards somewhat its passage, and gives time for absorption to deprive it of the major part of the chyle which it retained. The transit is therefore slowly performed here, and when effected, the matter has obtained the characters of excrement. Still it is tolerably fluid in the cœcum, and the ascending and transverse portions of the colon; it is much more dense in the sigmoid flexure, and, when accumulated in the rectum to solicit the act of defecation, it presents the consistence which we see after its issue.

These changes suppose that the absorption of chyle is continued to a certain degree in the course of the large intestine. It seems to me probable, also, that the assimilation is not limited to the stomach and duodenum. The small intestines are moistened, during the passage of aliments, with a fluid which cannot be regarded as foreign to this process, especially in their first portion, which bears the name of *jejunum*. This term comes from its being always empty, which has been referred to the more rapid absorption in the ileon. For myself, I hold it to be an incontestible fact, that the obstacle which is met with at the end of this intestine, by the narrowing at the valve, is the principal cause of the fulness which the former offers; and, it is equally certain, that absorption is very active in this region, since we find in the corresponding portion of mesentery an immense number of lacteal glands, and even the more of them the nearer we approach the cœcum. I should be induced therefore to believe that assimilation is still considerable in the ileon, and that it diminishes at the same time that the absorption

augments, in proportion to the nearness to the large intestine. I shall return to this question in the pathology of the assimilating function.

If we examine the organic relations which take place during the progress of the alimentary matters from the stomach to the cœcum, we shall find them analogous to those which we have remarked in the first digestion, but they are evidently less delicately graduated. We see indeed a stimulation of the mucous surface, by virtue of which the secretion of bile, that of pancreatic juice, and of mucus, more or less an assimilator, are solicited. The call made on the bile is very considerable in the duodenum, but it is not limited to this intestine. Pathological anatomy apprizes us that, if there be a portion of inflamed jejunum, the bile, as well as an albuminous fluid which may be attributed to the pancreas, is always found in it in abundance. We are far from discovering so large a quantity in the phlogosed parts of the ileon; which proves, in my opinion, that this portion of the small intestine has less connexion with the two grand secretory organs annexed to digestion, and that consequently it possesses less of an assimilating function.

The second organic relation of the internal sense, and which is exercised between it and the muscular coat, seems to me less delicate than that of the stomach, since the small intestines do not retain their contents for so long a time as this viscus, and do not move them about with the same regularity. Still, however, the same phenomena are met with here, in certain substances being longer retained, and arriving sooner at the large intestines, than many others, and sometimes these matters take a retrograde direction in the intestinal cavity; but as these differences are especially notable in the pathalogical state, we shall reserve them for the last section of this chapter.

The excrementitial matters contained in the cavity of the large intestine, are there submitted to a very slow progression. This organ is one of deposit, and must consequently be much less moveable than the superior region, which is but a place of transit. The cells of the colon aid in the retention of its contents. In it the organic relations are infinitely more limited; the appeal made to the grand secretors is null in the normal state; that exercised on the mucous follicles is very limited, and reduced to the secretion of a sufficiency of mucus to avoid dryness and constriction,—phenomena which are as yet but too common. It is clear, that if this relation had much activity, the matters would be always liquid, and could not remain there. It is not less evident that, if the colon

possessed a sense of a delicacy similar to that enjoyed by the stomach, or even the small intestines, it would act too powerfully on the muscular coat, and thereby render defecation much too frequent: pathology proves these two positions. A certain degree of torpor, a state of almost permanent tonicity, constitute then the most ordinary mode of vitality of the mucous membrane of this intestine, and of the muscular coat annexed to it.

Still, however, this torpor is susceptible of an interruption, which constitutes a part of the normal state; for at the end of a certain time, the fæces do not fail to revive the irritability of the mucous membrane. The sense with which it is endowed, is awakened; it acts with force on the secretors of mucus, and on the muscular parietes. The large intestine at this time enjoys a degree of activity equal to that of the superior region of the canal, and it retains it as long as is necessary for the excretion of fæces; as we shall soon be well assured after examining those relations of the digestive canal, which suppose the intervention of the cerebral centre.

These relations, like the preceding ones, take place by a modification of the stimulus of the gastric sense; over which presides a vasculo-nervous matter, which is continuous with the nerves of the eighth pair. When the surface in which this sense resides is stimulated by aliments, its action is not limited to the effect on the adjoining secretors, and the muscular coat to which it is adherent; it gives notice by means of the eighth pair to the centre of perception, of the kind of stimulation it receives. If this is for the well-being of the animal economy, the individual experiences a sensation of joy: the brain reacts on all the senses, which become more active; and on the muscular apparatus, which acquires more energy; in a word, there takes place an agreeable innervation, which solicits the percipient centre to continue and hasten mastication and deglutition. The heart receives its share of this stimulation, and doubtless the great sympathetic contributes to the same end; but the brain plays an important part in this, because pleasure is felt, and pleasure never fails to act, at the moment in which it is felt, on the principal organ of the circulation.

From this increase of innervation exercised on the entire muscular apparatus, and on the heart, results accelerated circulation; a greater quantity of blood is thrown into the viscera; those of digestion profit by it to furnish the requisite secretions, and muscular contractions; the lungs are found to display a new degree of activity; they command more extensive movements of the dilating

muscles of the chest; respiration becomes more accelerated and full. The brain, stimulated by a more considerable afflux of blood, continues to act more powerfully on all the muscles; and a kind of febrile condition is established. We may even remark, that, in the first period of digestion, when the blood is precipitated towards the viscera, this fluid is lessened in the external tissues; and, if the atmospherical temperature be reduced, there supervenes a chill of some minutes, followed very promptly by a reaction which gives warmth and colour to the skin on all parts of the body.

Such are the first phenomena that announce the influence of the gastric sense over the nervous matter of the encephalon. We find that, setting out from the internal surface of the stomach, the stimulation is diffused by means of the encephalon through all the regions of the body. Were it, in fact, limited to the muscular coat, and the secretors auxiliary to digestion, the intellect and the entire muscular apparatus would be strangers to it; we should not experience that feeling of content and strength, which produces gaiety, and promptly restores vigour to the limbs. The heart might have been without doubt excited, but never to the extent to which it becomes by cerebral innervation. Observe also, that the other internal senses, and especially the pulmonary, acquiring more activity by the sympathy which unites them to the stomach, are placed in union with this latter, for the purpose of appealing to the brain, and redoubling the action of the cephalo-splanchnic muscles. I have already said, that the afflux of blood to the lungs at this time is another very powerful cause of the augmentation of action in the respiratory muscles; and this arises from the respiratory surface, diminished by the sudden engorgement of the parenchyma, receiving a smaller volume of air than before, by which it is obliged to solicit more frequent inspirations. It is thus, that we find manifested the reciprocal influence of the internal functions on those of relation, and of these latter on the former; but we must fix for a moment our attention on the different sensations, which the intellect refers to the stomach during the chemical changes of digestion, because each of them developes somewhat different sympathies.

The first, and most remarkable, is that which pertains to gastric digestion: all the regions of the stomach are perhaps susceptible of it: I have not the proof, but it seems to me evident, that the cardiac region is its principal seat. The following is what occurs. So soon as a mouthful of aliment and one of wine are swallowed, we experience, if the stomach is healthy, that is, if it is not too much

irritated, a feeling of comfort and strength, referred to the entire locomotive apparatus, and which seems to be the effect of a mild warmth felt in the stomach. The pleasure which engages us to continue the alimentation may, perhaps, be felt in the entire extent of this viscus, since this latter is contracted, and the alimentary mass touches it in all points; but towards the end of the repast, when the stomach is distended by food, and there follow satiety and distaste for solid substances, the mouthful of wine which we swallow, is at the moment of its descent in contact only with the cardiac region; and yet the same pleasure is felt at the very moment, and depending then on the stimulation of this region. This portion of the gastric sense plays, of course, a very important part, as a stimulator of the centre of perception, during the whole period of ingestion.

When satiety has reached its maximum, the cardiac sense no longer responds in an agreeable manner to the stimulation of spirituous liquors; the mucous tissue in which it resides, has become hot, and even burning, and to the desire for stimulating has succeeded that for cold drinks, the contact of which with the cardia revives the vigour exanimate by excessive stimulation, as had been done before by the contact of vinous and alcoholic liquors, when the stomach, relaxed and chilled, required irritants. We would even go too far in the ingestion of watery drinks, were we not arrested by the sensation of fulness which depends on the general distention of the viscus. This sensation joined to that which results from refrigeration, soon restores to the cardia the property of being agreeably affected by spirituous drinks; and if we recur to the use of these latter, the stomach being filled with water, they hasten digestion, and the desire for solid food is soon renewed.

Thus then, in my opinion, the pleasure of alimentation specially depends on the agreeable stimulation of the cardia; and satiety on the distention of the stomach. But we must distinguish two kinds of satiety; that for solid aliments, which allows the desire for drink to remain; and that for drinks, which only withdraws for a moment the desire for solid food. These two satieties arise, without doubt, from the modification of action of the entire stomach; but the cardia is the point in which they are manifested at the moment of its being brought into contact with the *ingesta*. We learn from these remarks the degree of delicacy of the gastric sense, and how it becomes the faithful interpreter of the wants of vital chemistry, for the centre of perception.

The want of aliments and of drinks being gratified, the feeling of comfort and strength, which the ingestion had produced, gradually diminishes, and is finally no longer experienced, because it is not kept up by new aliments, and because the remembrance of the famelic weakness is diminished and insensibly weakened. The individual now feels himself fit for every kind of muscular exertion; but no longer experiences that state which invites him to display his strength, unless he be excited thereto by another instinctive want, or by the calls of intellect. But if these causes of stimulation are wanting, and if the repast has been copious, a fresh instinctive want is manifested, especially if the body was fatigued before the ingestion; it is that of repose and sleep. It seems to me to be produced by cerebral congestion, the necessary consequence of the digestion of a large quantity of aliment: this want is incomparably more pronounced if the food have been mixed with a certain quantity of fermented drinks.

If a man attends to his feelings during digestion, for the purpose of distinguishing the sensations corresponding to the different periods of this chemico-vital operation, he discovers, that to the very lively pleasure of ingestion soon succeeds a confused feeling of comfort through his whole frame; but he perceives nothing very distinct in the stomach, until this viscus frees itself from the chyme formed from solid food; for the absorption of water, useless in the digestion of solid aliment, is performed without causing any remarkable sensation. During this time the alimentary mass is driven towards the left hypochondrium, and is contained in the great arch or fundus of the stomach; but after a period of three or four hours, a mild heat is felt in the sub-umbilical region, accompanied by a feeling of emptiness and relaxation in the stomach. Gas often escapes; the lower belly is raised at the same time that the epigastrium sinks, and the desire to urinate is felt anew. We may also make the interesting observation, that the breathing, which during the first hours was pectoral, becomes now manifestly more abdominal, and much less frequent and expansive. These signs indicate the passage of the chymous mass through the pylorus and duodenum into the small intestine. Commonly the heat of the skin, and perspiration are augmented; many desires, such as those for muscular exercise, thought, and generation, which had been, as it were, suspended during the process of the digestion of substantial food, are now felt sometimes with more energy than immediately after the repast. This is the period in which man is best fitted for every

kind of corporeal and intellectual labour, because he is less excited, has more power of resistance, and more breath. He is not distracted then by any disagreeable sensation; and this is what it is so important to be well apprized of, in order to distinguish the slightest shades of irritation of the digestive apparatus.

This stage, which constitutes what we call second digestion, varies in its duration, according to the quantity of aliments taken.—If they were in small quantity, it is completed in one or two hours: if the meal have been an abundant one, the second digestion is prolonged much more, and sometimes even lasts from fifteen to twenty hours. During this time the alimentary matter is found both in the stomach and intestines, for the stomach only gradually frees itself, by directing in successive waves towards the pylorus, the matters which ought to pass the first, according to the order of their digestibility, of which we have already given an account. It may be observed, that under these circumstances, that is to say after heavy meals, the chyme which last remains in the stomach becomes always very concentrated, and exercises on the mucous coat a stimulation which is productive of thirst. It is then that a small quantity of water hastens the passage of this residue, and more promptly recals the sensation of hunger. Still, however, this latter, which is very gradually felt, only becomes urgent when the small intestines have definitively transmitted to the colon the entire chymous mass which had been so long in traversing them. This fact seems to prove that digestion is continued in the small intestines.

Section IV.—*Of Defecation. Encephalic Relations of the Large Intestine.*

We may have observed, at the different epochs of digestion, an action, simultaneous and conformable with the actual state of the viscera, in the cephalo-splanchnic muscles belonging to each region of the trunk. Thus, during the first period, when the stomach was full and the lungs engorged with blood, the intercostal muscles acted with much energy in raising the ribs; the diaphragm and the upper fibres of the abdominal muscles allowed themselves to be distended by the stomach; finally, the inferior portion of these same muscles, which corresponds to the sub-umbilical intestines, and the hypogastrium, persisted in a notable degree of contraction. When, again, the chyme, allowing the turgescence of the epigastrium to

subside, has spread itself in a sinuous stream in the small intestines, we see the pectoral muscles diminished in size, the diaphragm depressed, the upper sections of the sterno-pubien muscles and the upper fibres of the transverse and oblique contracted, whilst the expansion of the chest is performed by the developement of the umbilical and hypogastric regions, the intestines in which have just acquired an increase of action. We have witnessed all this in the clearest manner ; now we have to observe not less evidently this same cephalo-splanchnic motor apparatus obedient to the modification of the large intestine alone.

At first the accumulation of fæces in the cavity of this organ provokes no other noticeable sympathy except a slight relaxation of the muscular fibres of the corresponding parietes, accommodated to its enlargement, by which the abdominal surface is somewhat increased; but so soon as the peristaltic movement, until then very slow, has accumulated a certain quantity of excrementitious matter in the rectum, the irritation which they produce on the anus gives rise to a quadruple series of sympathetic movements. First, the fibres of the rectum and colon begin to contract through the whole extent of these intestines; and immediately after, the abdominal muscles and the diaphragm imitate them, and exert on the abdomen a mild pressure which is, however, not yet commanded by the will. Then the insufficiency of this effort causes a certain degree of pain, which produces an appeal to the brain, and thenceforward the will is forced to impart to the muscles above mentioned, an impulse which instinct alone could not communicate to them. But all this does not yet suffice ; we require an attitude for fæcal discharge, a point of support for the inspiratory muscles, to keep the chest immoveable, in order to direct all their action to the abdomen: now this point of support can only be found in the limbs ; the will is then obliged to let the muscles that are under its dependence concur with those which are primitively obedient to the viscera ; and it is by this admirable union of synergetic efforts that defecation is accomplished.

If we study digestion in the different ages of life, the sensations will not always be found as above described. The child does not know how to give an account of the irritations of its viscera; the adolescent does not pay attention to them unless he be sick ; the adult begins to observe them; but the man who is in the decline of life lets nothing escape him, in the exercise of the internal functions.

Education and the kind of life, also have great influence on the

manner in which men are made sensible of the state of their viscera. Persons practised in muscular efforts, and whose intellect is not cultivated, only experience confused sensations in the gastric passages, except in a very decided pathological state; whereas, these organs make themselves felt in a very distinct manner in those who continually and from an early age exercise their intellectual faculties. It is worthy of remark, that sensibility, so far from being blunted, becomes more delicate in proportion as we advance in life; at fifty years of age a man is more sensitive than he was at twenty; nor can this be attributed to any other cause, but the habit gradually acquired of analysing the sensations resulting from the stimulation of the different sensitive surfaces, external as well as internal; it is the education of the part of the brain destined for intellect, or, in other words, of that faculty which the philosophers have called *consciousness.* It has been observed that warm climates contribute to perfect this faculty; for men inhabiting them are more sensitive than those of the north; hence they give their physicians a much clearer idea of internal irritations, and above all of those of digestion. This last remark, however, having been made by all physiologists, I do not deem it necessary to dwell on it any longer.

SECTION V.—*In what manner the Exercise of the Organs of Digestion becomes the cause of Disease.*

To elucidate this question, we must study the digestive organs in their relations with the external agents capable of modifying them. What at first meet our notice, are the pathological phenomena from the absence of these agents, that is to say, the morbid effects of hunger and thirst.

If there be facts which prove the source of our wants to be in the exercise of our functions, they are assuredly those of which I am now to treat; and which show that the deficiency of stimuli produces in some of our organs an excess of excitation. In fact, when the stomach does not any longer receive the aliments to which it was accustomed, it begins to be chilled; which announces a languid circulation in its capillary tissues. The same languor, the same chilliness, are manifested in all the other apparatus, because they are no longer excited by the stomach, and especially because the heart, being less stimulated, sends to them a smaller quantity of blood. The first shade of a pathological state which results from a defect of aliments, is therefore weakness: but the

stomach is a singular organ; its destiny is to be always irritated, and therapeutists ought never to lose sight of this important fact. If then it be not thus affected by the presence of aliments and drinks, it becomes so in their absence: it is contracted and irritated; it invites blood, and draws towards it the fluids secreted by its annexed organs.

Must we have recourse, as an explanation, to the deterioration of vital chemistry, which super-animalizes, to make use of an expression of the chemists, the free and circulating matter? Does there result from this modification a super-irritation of the solids or fixed matter, which can only be now renewed by materials inadequate to its wants? This super-irritation being perceived by the sensitive centre, does it produce the pains of hunger and thirst? I believe that the actual state of our knowledge justifies our replying affirmatively to these questions. Is it a law that this super-excitation which I call *famelic*, should be stronger in the stomach than any where else, and be at first referred to this viscus?* I believe so; it seems to me quite natural, and analogy confirms me in this opinion. Is not the irritation which results from the defect of respirable air first referred to the lungs? Is not the desire for coition first felt in the genital organs? that of defecation in the large intestines? that of the ejection of urine in the bladder? It will perhaps be objected that these last mentioned wants arise from the superabundance of the stimulus fitted to each organ. That is incontest-

* We see here the chain which connects vital chemistry with intellect. Are we not indeed led to believe that the nervous radicles collect the stimulation produced in the tissues by the degeneration of living matter; that these radicles convey this stimulation into the splanchnic nervous apparatus, since the stomach is irritated; that the nerves of the eighth pair transfer it to the centre of perception; that this latter, while contemplating as it were this excitation, diffuses it through the sensitive and motor nerves; finally, that the painful stimulations which it receives from the stomach, induce the thoughts of food, and force the will to the actions necessary to procure it? It is when in this state, that the centre of perception best recognises the impressions made on the external senses by alimentary substances, because these impressions augment the famelic irritation. Let, nevertheless, a profound sleep supervene; all the desires are suspended, because the condition of the brain, which was dependent on the waking state, no longer exists: now it is this condition of things which makes the state of sensibility, that constitutes consciousness. What then becomes of sensibility and consciousness during sleep? Where are these faculties, the only source of whatever is sublime in human conceptions? Where were they in the fœtal state? There is nothing more than an aptitude to their existence, depending on the state of life.—The stimulations, however, of these organs, and their transmission to the brain, still take place, as is proved in epilepsy. So far the facts: let the psychologists explain them; if they cannot, let them imitate us,—be silent and admire.

able. It is very certain that the semen when not ejected is concentrated by absorption, and is super-animalized; that the urine and fæces undergo the same alteration; but why should not there be a similar change in the stomach? May not the gastric fluid be accumulated in the gastric cavity, and become an inconvenient stimulus to it? Many physiologists have thought so. Hunter believed that this juice became acrid, and by its delay, in cases of long fasting, acquired such great activity as to dissolve the internal membrane of the stomach, and even to cause a perforation (P.) I do not admit that things take exactly this course. The faculty of the gastric juice to digest the organ which furnishes it, cannot, in my opinion, be attributed to it, for digestion supposes a concurrence of the action of the mucous membrane and assimilating juices. But is it not possible for this fluid, when too concentrated, to irritate the mucous coat and give rise to an inflammation capable of producing these organic alterations? It will, perhaps, be alleged in reply, that it is too hasty to attribute evident changes to a humour, the very existence of which is hypothetical. Well, then, if we repel the idea of a solvent fluid secreted by the stomach, we are forced to admit the presence of a mucus in this viscus, which is peculiar to it, and that of saliva, which descends continually into it. These humours may be depraved, and the irritation to which they give rise draw in the bile and pancreatic juice. Hence I believe it will be difficult not to admit that these fluids must be concentrated, and aid in the super-irritation of the organ.

However this may be, it is very certain that hunger does not fail to produce thirst; that the stomach becomes over-excited, and finally inflamed, and ends by exhibiting all the sympathies of the best defined gastritis. It is then that the pains become atrocious in the stomach and parts corresponding; and if we would remedy them, we must proceed by giving small portions of cool water, gradually increased in quantity.

The thirst produced by the want alone of watery drinks, tends to the same result, the phlogosis is developed in the pharynx and stomach, solid aliments cannot be tolerated, and death takes place here as in other cases, always preceded by sadness, anger, and convulsive movements. It seems to me probable, that the arachnoid is often affected with phlegmasiæ, for I have almost always found it opaque in those who perished from gastritis; and Dr. Scoutetten, who was for a long time my clinical dissector, has given this fact in his inaugural dissertation. It is now many years since I first

wrote, and still longer since I announced in my lectures, that the brain and stomach communicate reciprocally irritation to each other. Even in the *Histoire des Phlegmasies*, on the occasion of the death of young Beau, who is the subject of the first observation in the second volume, first edition, I had held out the idea, that the brain, irritated by the sufferings of the viscera, could invite into its tissue a sanguineous congestion, and undergo an inflammatory modification. [See, also, the propositions which are at the beginning of the *Examen des Doctrines Médicales*.] It is, then, well proved, that the deficiency alone of stimuli adapted to the sensibility of the stomach, can give rise in it to a super-stimulation; with still more reason can it be produced when this viscus is overcharged with excitants: but it will be remarked, that those which are adapted to its vitality will offend it much less than those which are repugnant to it. Let us next examine into whatever is appreciable in the lesions which it suffers from both of these sets of agents.

Whenever the stomach is engaged in the process of assimilation, it is irritated, calls to it blood in abundance, contracts with energy, is heated, and reacting on all the sensitive tissues, it becomes a very active centre of irritation to the animal economy. Restrained within just bounds, this excitation is favourable to the exercise of all the functions; too exalted or too often repeated, it becomes a universal disturber, and a source of organic disorder both to the viscus itself and to those which sympathise with it. Alible substances of the most healthy kind, may then generate the same evils as would follow from a deficiency of food.

Among the numerous organs that participate sympathetically in the excess of gastric irritation, there are two which seem to be more frequently affected than all the others: these are the liver and the encephalon. The first because it is forced to an excess of secretory action, by the over digestive activity of the stomach; the second because it is destined by nature to be obedient to all the gastric irritations, of whatever kind they may be. In fact, in hunger and thirst, must not the will be drawn along by the influence of the stomach, in order to direct the actions necessary for the gratification of the want, even when reason would oppose obstacles to it? Is it not necessary, during alimentation, for the intellect to be apprized by pleasure or by pain, of the useful or hurtful qualities of the substances which are presented to the mouth, or which reach the gastric cavity, in order that the individual may continue or

suspend the ingestion of them? During gastric assimilation, is it not indispensable for the centre of perception to be informed if the process be done in a manner injurious to the well-being of the animal economy, in order that man be directed to seek instinctively a remedy in the bodies which surround him, in drinks for example, or to ask it from those of his like, to whom observation, experience, and reason have imparted it.

We have already said, that all these phenomena are in the province of instinct; they prove to demonstration, that the stomach can never be over-irritated without the liver and brain participating in it. It will not then excite surprise to hear us say, that these organs must be the first by their diseases to participate in the disorders of nutrition. We shall thus acquire evidence, that, if it be an over-irritation, which the stomach undergoes in consequence of its having been forced for too long a time to digest the healthiest aliments in very large quantity, the diseases that the liver and brain will contract simultaneously with this viscus, must be exactly of the same nature. Now this is what is attested every day by facts of the most positive nature, and this is what I propose developing, in the most succinct manner possible. I will first examine the morbid alterations of the stomach, and then exhibit those of the liver and brain depending on them.

I have already spoken of the rising of the stomach, and even the vomiting, which are occasioned by the disagreeable impression caused by certain aliments in the act of mastication. I have likewise pointed out the hiccough, which supervenes from an obstacle to the passage of the alimentary mass, while traversing the œsophagus: it is needless to dwell on the chemical lesions, more or less painful, which may be produced in the mouth, pharynx, and œsophagus, by certain substances, such as acids, alkalies, puncturing or lacerating bodies. Let us pass on then to an examination of what happens in the stomach, when it is engaged in the assimilation of the substances that have reached its cavity.

Two phenomena, we have said, necessarily take place during digestion; the assimilation of alible matters, and a notice transmitted to the centre of perception as to the manner in which this assimilation is accomplished. The first is in the province of vital chemistry, which calls to its aid contractility, in order to attract the fluids, and excite the necessary movements of the splanchnic muscles. Is all this performed in a quiet manner, and conformable to the good of the animal economy, we experience a feeling of

gaiety, strength, and hope; the intellect is pleasurably affected. Is the afflux of fluids too impetuous, are the local muscular movements too exalted, there is inconvenient heat of the epigastrium; this is repeated on the skin of the trunk, on that of the feet and hands, on the face, and in the interior of the cranium; the feeling of strength is diminished; the pulsations of the heart and arteries are too sensibly felt. Is the muscular parietes of the stomach too readily solicited to contraction, painful movements are felt in the epigastrium, gas, acid or alkaline, or of an alimentary odour, sent towards the mouth with impetuosity, a nausea, presentiment and fear of vomiting, uneasiness referred to the locomotive apparatus, breaking down of strength, tendency to drowsiness, accompanied by pains, and feeling of weight in the head, are among the accompanying symptoms; and in fine, the instinct is modified in a very disagreeable manner for the centre of perception.

Such are the first pathological effects of a laborious digestion with the excess of stimulation. If alcoholic liquors have been plentifully used, the exaltation is manifested still more in the encephalic functions than in the other viscera. Thus, to heat and rapid circulation are joined bursts of gaiety and afterwards of fury, delirium, excessive and even convulsive strength in the muscular apparatus,—the whole terminated by a sleep which sometimes approaches to the apoplectic state.

If, on the contrary, the drinks and aliment be of a nature not sufficiently stimulating, the two orders of phenomena, which we have just pointed out, are manifested at first in a quite different manner. In place of gastric, lingual, optic, and cutaneous injection and heat, we observe a sensation of cold in the epigastric region, and paleness and coldness of the surface; instead of a sensation of contraction and strength, there is that of weight, relaxation, and fulness of the stomach. This viscus is sometimes in so powerless a condition that there is not the least gas expelled from the mouth; the strength is then gone, and the pulse scarcely perceptible; speech and even thought become impossible; convulsions supervene, and we find persons sink in this state, with the stomach full of aliments, which had not, after the expiration of some hours, undergone the slightest digestive alteration. Such a death is the effect of pain, which depends on the internal gastric sense being disagreeably affected by the *ingesta* and its not reacting on them for the purpose of assimilation. The kind of excitation which it experienced only acted on the centre of perception, so as to cause convulsions, and the violence of

these latter exhausted life. In fact, death cannot result in such cases without convulsions; so true is it, that this viscus is so constituted that it can never remain any length of time without being excited; let it be in a manner adverse to, or congenial with, the well-being of the animal economy, it can never remain inactive.

This kind of death is, however, extremely rare; more frequently when the stomach refuses to assimilate aliments, they are gradually decomposed as they would be in an unorganized vessel, having the same warmth and moisture as the stomach. The new chemical qualities which these *ingesta* acquire by their fermentation or putrefaction,—the gases more or less opposed to vitality which are disengaged from them, exercise, a stimulation on the stomach by which it is filled with saliva, mucus, bile, and pancreatic juice; it becomes more and more swelled, its coats are red and engorged, still, however, without assimilation being performed; but its muscular coat is solicited to contraction, and its fibres approach, either to expel by vomiting, or to discharge through the pylorus, the foreign bodies that oppressed it, or even to bring about these two modes of action at the same time. The eructations are more frequent; borborygmi and colics announce the revolt of the intestinal canal: finally *ingesta* are evacuated in two ways, and as all the secretors annexed to digestion are excited by the rubefaction of the mucous membrane, which, we may remark *en passant*, does not take place in the kind of death above described, these *ingesta* are expelled, together with a great quantity of humours.

We can well conceive, that such movements of the assimilating apparatus cannot take place without a multitude of perceptions more or less painful, and a concurrence of muscular movements of every kind. It is of these latter which we are next to treat; for, whatever be the cause of vomiting, which may, as we too well know, be brought on by the healthiest food, as well as by various poisons, its mechanism is still the same.

When the stomach is inclined to vomiting, it begins by slowly contracting itself in an antiperistaltic direction, that is to say, from its pyloric to its œsophageal extremity. The muscles of its sides being forced to obey it, those of the abdomen are also thrown into contraction; the depression of the diaphragm, which is much less powerful than they, becomes impossible; it contracts, notwithstanding, by which means a strong pressure is exerted on the stomach, which is thus compressed between that muscle and the abdominal ones. This viscus is then as it were carried upwards, and we feel

it in fact exercising a kind of pressure under the base of the chest. This latter cavity remains immoveable to serve as a point to the mass of abdominal viscera; and to speak is impossible. The stomach continues to contract from below upwards; but the œsophageal orifice resists. When the moment for vomiting has arrived, instinct suspends the effort of the stomach, in order to obtain a full inspiration, which swells out the two pulmonary parenchymæ, followed by a still greater pressure of the diaphragm on the contracted viscus. M. Magendie thinks that with this inspiration there is likewise a deglutition of air, which renders the stomach still more compressed by the enlargement of its cavity. Finally, the antiperistaltic action of this viscus is propagated beyond the cardia, and pervades the whole of the œsophagus; this membranous canal opening receives the gastric contents, which it conveys into the mouth, and, to diminish the obstacle to their exit, this cavity is obliged to be opened: thenceforward the stomach continues to empty itself by fits, always preceded by an ample inspiration. Each time that the stomach thus frees itself, the air from the lungs, and which was retained for an instant by the constriction of the larynx, escapes likewise with a noise and general vibration of the bronchial tree. There results from this mechanism, that each effort of vomiting is accompanied with a fit of coughing; and as the mucous membrane of the nasal fossæ is in a state of congestion, caused by the retention of blood in the head, it undergoes a titilation, whence results sneezing. Thus cough and sneezing are associated with vomiting, which excites very copious evacuations of pulmonary, tracheal, and nasal mucus, to which are added an abundant excretion of saliva, and the humours from the amygdalæ of the mouth; for the glands furnishing the former are brought into simultaneous action. We find even that their secretion augments from the moment that nausea is felt; whence comes salivation. If to these evacuations be added those of the gastric juice, of bile and pancreatic fluid conjoined with the forced sweat, which the skin so abundantly supplies at this time, the blood being propelled with great violence towards the cutaneous surface by the obstacle which it encounters in traversing the chest, we may have some idea of the prodigious vascular irritation which accompanies the perturbating act of vomiting.

Nor is the irritation of the cephalo-splanchnic muscles less considerable; it is curious to observe the successive contractions of the abdominal muscles, and to see how they are embodied and directed upwards in order to raise the viscera, and press them under the arch

of the diaphragm: the voluntary muscles are not strangers to this general disorder; forced as they are by instinct to furnish a favourable attitude for vomiting, and a point of support for the trunk to rest on adjoining bodies, we find them all enter into action under the influence of the will; there are even cases in which the irritation of the viscera is carried to such a degree, that these muscles are thrown into the most violent convulsions.

The derangement of the circulation merits observation; the lungs, condensed, retain the blood which comes from the head, and prevent the emptying of the vena cava; the blood of the encephalon undergoes a reflux towards the face, and the teguments of the thorax and superior muscles; that of the abdomen, finding the viscera of this cavity less permeable, is thrown into the superficial vessels of the inferior part of the trunk and of the lower extremities. The skin is then strongly injected; and as it participates at the same time by sympathy in the irritation of the mucous visceral tissues, it furnishes an abundant perspirable excretion. The organs entrusted with the deposit of the excrements being too much pressed upon, are sometimes thrown into simultaneous action, and we see occasionally persons who let their fæces and urine escape in vomiting.

Such is vomiting considered in the adult, and when the locomotive apparatus has acquired some developement. But in the period of infancy, in which this apparatus is yet weak, vomiting is not near so difficult. Some physiologists, having observed this fact, have attempted to explain the process as taking place by a different kind of mechanism in the two cases: they have attributed vomiting in children to the stomach, and that of adults to the abdominal muscles; but it is evident that there can be but one method for this kind of evacuation. Hence we find, that when a child vomits, the muscles of the abdominal parietes follow the stomach; the only difference met with, between children and adults, is that the former have the stomach more irritable and more powerful in relation to the respiratory muscles. But in proportion as the individual advances in years, this predominance of the viscera over the rest of the body diminishes; and the muscles which move it are less obedient to the viscera, when these latter require an evacuation of their contents. Do we not find in fact, that defecation and the excretion of urine are very prompt, and by no means laborious, in the infant at breast; that they are often painful in adult age; that finally, in old age, the difficulty with which they are performed constitutes in

many persons a very inconvenient pathological condition? There is yet another circumstance which contributes to render vomiting much more easy in children; it is the greater volume of their abdominal viscera: but the same cause acts with equal power on adults; in equal ages we find more facility in provoking vomiting in fat than in lean persons, and in the extreme of marasmus it becomes absolutely impossible to produce this discharge. The reason is this: the volume of the organs contained in the abdomen being too inconsiderable to exert a pressure under the arch of the diaphragm, the abdominal muscles are required to supply their place: now this is impossible; and, as no viscus can cease to be in contact with the parietes which enclose it, unless a foreign body be interposed, the stomach can never attain the degree of condensation necessary for the act of vomiting to take place: in such cases, if this viscus continues to be excited in an antiperistaltic direction, the person is exhausted in vain efforts; it is as impossible for him to vomit, as for the consumptive, reduced to marasmus, to expectorate, and the anguish which they experience commonly ceases but with their lives.

It is from not having well understood this forced association of the cephalo-splanchnic muscles with the viscera, that some physiologists have supposed vomiting to be performed by the abdominal muscles. The ancients had affirmed that this evacuation depended on the contraction of the stomach: experimenters, in order to ascertain the fact, removed the muscles of the abdomen after having given an emetic, and they found the stomach continue in a state of quiescence. On these muscles being allowed to remain, it was remarked that they entered into contraction at the moment of vomiting. In place then of concluding from these experiments that the stomach required the assistance of the abdominal muscles to empty itself, and that they only followed because they could not abandon it, it was inferred that this viscus was entirely passive in vomiting; they would have had it abandon the abdominal parietes and mount alone under the arch of the diaphragm before they acknowledged that it was an agent of vomiting: but no evacuation is performed in this manner. Never does a hollow viscus, except it be the heart, empty itself when deprived of the aid of the cephalo-splanchnic muscles: it has need of such aid to overcome the constriction of the sphincters. Besides, the removal of the muscles of the parietes totally deranges the action of the subjacent viscera. So soon as the abdomen is opened in a living animal, the intestines are inflated and tend to escape outwardly, in place of being con-

tracted and emptying themselves. It is the same thing with the bladder and the lungs; and I am persuaded from analogy, that if the abdominal muscles were removed from a bitch in labour, its uterus would not expel the fœtus. Who has ever thought, however, of attributing all these evacuations to the respiratory muscles alone? Let any one attempt to produce defecation when the expulsive movement is not developed in the muscular coat of the colon and rectum, and he will never accomplish it. There is no effort, whether voluntary or convulsive, which can bring on vomiting or labour, unless the stomach or the uterus experience in its tissue the contractions necessary for the expulsion of its contents.

Stress has been laid on another experiment, to show that vomiting depends on the muscles of the abdomen. A hog's bladder has been substituted for the stomach, and made to communicate with the œsophagus and duodenum; tartar emetic has then been injected into the veins, and vomiting has in consequence taken place. But it was not considered that any other substance which excites convulsive contractions, would have produced the same effect. Simple pressure of the hand could have occasioned it, because this inert bladder has not, like the stomach, the faculty of retaining its contents. This kind of vomiting is then purely mechanical; and only shows that an emetic excites convulsions, but by no means that which was desired to be proved by it. If this bladder be examined at the termination of the experiment, it will be found folded and wrinkled, and the intervals between the wrinkles will contain a portion of the fluid which had been introduced into its cavity; this is because it is not contractile like the stomach. In fact, if this viscus were as inert as the bladder, the former would also be wrinkled in vomiting, and would never be completely empty. There are, however, a host of cases in which it expels all its contents: it has contracted in all points, and, if it contracted, it was not passive in vomiting.

The partisans of the opinion which I combat do indeed grant that the stomach contracts, but they affirm that, in doing so, it merely imitates the abdominal muscles. But were it thus, why not imitate them whenever they exert a violent pressure on it?

Finally, if the stomach be not the primary agent in vomiting, why does it expel certain substances while it retains and digests many others? In children, at the breast, it only rejects what is in excess, and turns the remainder to a very good account. This fact

is so common, that nurses are in the practice of saying that the child which vomits, thrives. In the greater number of gastrites, which have not become intense, the stomach rejects mucus and bile after a meal, and retains the food. This viscus acts in the same manner in reference to the pyloric passage, as we have already pointed out. If we wish for other experiments, pathology will supply them to us. An account has been published of a sick man who could no longer digest, and who rejected nothing by the mouth. His stomach was always full; and dissection after death showed that it had no longer a muscular coat. Its tissues had undergone completely the fatty degeneration. Here we have enough to convince us that the stomach is the primary and necessary agent in vomiting; and I should be ashamed to have been stopped to refute the contrary opinion, if those who sustained it, for it had been advanced before the present time, did not enjoy on other grounds a well merited consideration.

What then is this function, in virtue of which the stomach separates the matters mixed and confounded together in its cavity, so as to retain some and discharge others? It has doubtless aided, together with other phenomena not less singular, in the admission of an *archæus* in the epigastrium. I shall not now discuss this opinion, but the faculty of which I speak admits of a very plausible explanation; affinity may to a certain extent account for it. Thus, when substances are presented to a pylorus too sensible, there begins from this extremity a movement of antiperistaltic contraction, which drives them towards the cardia. This movement is propagated to the œsophagus, now open to receive these substances, and still farther prolonged to the pharynx, they are conducted into the mouth, which rejects them as causing a disagreeable sensation to the centre of perception, but which can, if the will requires it, swallow them again. This is rumination; it is done without pain; only with some dislike; a slight contraction of the superior region of the muscles of the abdomen follows the stomach in its ascension. It is thus that the viscus frees itself of its too great distention in a child, and in persons who have taken too much aliment, and who are possessed of an irritable stomach. In such cases there is no choice made among the substances contained in the stomach; it only rejects what is found near the cardia, at the moment in which the peristaltic contraction reaches this orifice; but the movement is not then sufficiently violent to have all rejected, nor to force the mouth

to remain open, and render it impossible for the portion of chymous matter which had been returned to it, to be subjected to a fresh deglutition.

It remains to be ascertained why substances which are disagreeable, are alone rejected in certain cases, whilst the rest remain in the stomach. I can only account for the difference, by supposing that the substances which are suitably digested are retained in its cavity by a vital affinity, which makes them adhere to the sides of the stomach; I will not say that the stomach chooses, separates, makes a division by a kind of thought, but that it rejects by a general antiperistaltic action depending on the painful sensation of the pylorus, and that the molecules which agreeably flatter the gastric sense are retained in spite of this general movement of repulsion.

We can, by this explanation, very well conceive how the matters disagreeing and not digested, should remain free in the centre of the mass, and be presented the first to the cardia during the contraction of the stomach. This can, in fact, only take place because no portion of the mucous surface attracts them to it. At any rate, this phenomenon is not peculiar to vomiting; the experiments of M. Sarlandière show that it takes place equally at the pylorus, since the most nutritive aliments are retained the longest in the stomach. Besides, a similar process takes place in the small intestines; and Magendie himself, who will not be accused of being too much of a vitalist, has made the remark in express terms. This gentleman saw the chyle attached to the mucous surface, and continuing adherent to it, whilst the indigestible substances destined to form the excrements remained free, and were obedient to the peristaltic movement which conducted them towards the large intestine. Now, it seems to me, that the choice of matters to be vomited can only depend on a similar mechanism. We can conceive, at present, how the mucosities produced by a slight gastritis, the bile which this irritation calls in too great quantity into the stomach, the blood which this organ exhales in some hæmatemeses, may be thrown up, even with some marked efforts to vomit, without aliments of easy digestion, and which flatter the gastric sense, being rejected.

We may explain, likewise, by this means, why natural vomitings seldom empty the stomach entirely, and often allow nutrition to go on for a length of time; such are those in pregnancy, in nephritic

affections, in sea sickness, and even those from phlegmasiæ of the pylorus of a moderate grade, which often admit, for a term of years, of a certain degree of strength and fulness of habit. It is because in all these cases the gastric sense is not entirely perverted; it is not at all so in pregnancy or at sea, &c., and in all the affections of the pylorus, and other partial phlegmasiæ of the stomach, it is only so in a small portion of the mucous surface of this viscus. But the case is far different when emetics, and especially those of tartrate of antimony and potass, are used. These substances make a direct attack on the sensitive expansion of the stomach; they irritate it, produce an unnatural afflux towards it, and tend to inflame it; in a word, it is by depraving this internal sense, the integrity of which is so important to the preservation of life, that these poisons, for no other term is applicable to them, produce that general revolt of the stomach which gives rise to such painful sympathies during the perturbating act of vomiting.

We can judge from these views, how dangerous it is to make too frequent use of emetic medicines, in cases in which the abuse of irritating ingesta or the influence of another organ has deranged the regularity of digestion. What will be the effects of administering emetics in cases in which the surface of the gastric sense is a prey to inflammation? The sick can only escape this kind of poisoning by very abundant revulsive evacuations; and often, even after these have taken place, there remains a phlegmasia of the stomach, the cure of which is exceedingly difficult: it is thus that the pretended adynamic fevers are produced in the practice of the ontologists, humoralists, and mechanists. But if, following in the steps of the Italian Rasori, physicians give in rapid succession doses of tartrate of antimony and potass, the amount of evils is still greater. The vomiting ceases at the expiration of some hours, but it is because the spasm of the stomach becomes permanent, and it only becomes so by excess of irritation of the mucous tissue; hence the gastric sense continues to be depraved, and profoundly perverted, in those who have been treated by this method. Digestion is often destroyed for many years in most of them; they retain a chronic gastritis, with a convulsive disposition of the stomach and small intestines; they become hypochondriac, and neuropathic; and if, unhappily, these infirmities be attributed to weakness of the stomach, if we add to the evils which afflict them, a prodigal use of tonics, their life is nothing for the future but a succession of calamities.

The most melancholy end awaits them, either from a scirrhus or softening, the effect of the slow and progressive inflammatory dissolution of the membrane in which the gastric sense resides. It is my duty to point out these errors, because they serve to throw light, in place of experiments, on the mechanism and effects of vomiting; because they are connected as causes of disease, with the disorders of the digestive functions ; finally, because it is high time to put a stop to the contagion of Rasorism, which threatens to seize on our schools, and to replace the system of Brown, of which our countrymen begin to be ashamed. (Q) I continue the inquiry into the diseases which have their origin in the exercise of the function of digestion.

We must place on the next line with emetics and purgatives all mineral preparations, all bitters, acrid substances, and corrosives in small doses ; in a word, all medicinal agents which obstinately resist assimilation. If some among them seem to revive the digestive function, it is an illusory advantage ; they all produce in the end a slow phlogosis, which depraves the normal or natural action of the gastric surface, and its disorganization is the necessary consequence.

Certain foreign bodies, such as bones and pieces of metal, are sometimes rejected by the pylorus, without being received by the œsophageal orifice, and remain a long time in the stomach. Persons known to be tormented by the presence of these indigestible matters, have had repeated vomitings without being able to get clear of them; but what is most surprising is the innoxiousness of such substances during a certain time. One has reason to be astonished, when he sees to what an extent the stomach may resist this cause of irritation in robust persons. We sometimes see jugglers, as they are called, polyphagi, who, for a series of years, swallow with impunity, flints, knives, and other like substances ; they, however, all end by sinking under inflammation of the stomach and intestines. We can conceive that beings thus privileged will suffer less from the abuse of emetics and tonics ; and it is on such data that people prescribe with so much boldness these medicines to delicate constitutions !

It is not simply foreign bodies that exalt the sensibility of the stomach ; the most healthy and nutritive substances, those, which in a normal state produce an agreeable excitation, raise the strength, revive and exhilarate the moral faculties, will finally injure the health, pave the way for a miserable existence, and greatly abridge

the duration of life. No longevity for gluttons and drunkards, has been long said; but the true reason has never been given. We are now going to attempt the examination of this subject, which so nearly interests the manners and happiness of society; but we must set out from the point whence we deviated, and explain the bad effects of indigestible substances, which hitherto we have merely hinted at.

The stomach, as we have seen, displays, for the digestion of aliments, an action proportionate to the difficulty of their assimilation; but for this purpose there must exist a certain affinity between them and it; otherwise, that is in the cases in which they are indigestible, it is solely tormented in efforts for their expulsion. In the first case it is on its internal membrane that the greater part of the excitation occurs; in the second this membrane does not act for the process of assimilation, but rather causes muscular movements of expulsion, either through the pylorus or cardia.

We understand, after this reflection, how the abuse of indigestible *ingesta* tends to deteriorate the assimilating action of the mucous membrane, and to give the muscular a convulsive habit. It is on this account I asserted that mineral medicines in the end destroy the digestive function, and consequently nutrition. Many vegetable substances, we have said, have nearly the same effect, when they are of such a nature as constantly to resist assimilation. The kind of phlegmasia thence resulting becomes in time incurable, and this is the situation in which are those who have used in excess bitters not nutritive, and Peruvian bark. Still, however, the alteration thence resulting seems to be less alarming than that produced by minerals. The too prolonged use of calomel, corrosive sublimate, and purgative salts, is then still more pernicious, and we see, in fact, that those who have been addicted to such things become pale, exanimate, and scorbutic, and end their days in a state of marasmus or dropsy. It is not the digestive surface alone that suffers from their pernicious effects, but the whole animal economy. The depurating power, always occupied in the expulsion of mineral molecules, is exhausted; the nervous system loses its energy; there is no longer any reaction against the perturbating influence of the air or of moral affections, and new congestions are formed at each moment in the viscera and the tissues of the locomotive apparatus; engorgements arise in the lymphatic system, in the principal secretors, such as the liver, &c. and a vicious nutrition of heteroge-

neous tissues is created, the resolution of which is afterwards impossible. Hence those dropsies, and the scorbutic states of which I have spoken.

But how remedy the like disorders? Will you prodigally administer stimulants, with the view of reviving gastric assimilation; and thus renew the phlogosis, which, from being latent, becomes acute, and hastens destruction. Will you limit yourself to the employment of nutritive substances of the most benign character, such as gelatin, albumen, milk, what, in a word, is called with us *the white regimen*, the stomach is not sufficiently stimulated: these aliments remain in the viscus, without being digested, or else they are expelled by vomiting or diarrhœa, and the debility goes on increasing. Such are the inconveniencies of the abuse of indigestible substances intended to reanimate the stomach, to keep the bowels open, to break down mucosities, and remove obstructions. Let us now place on the same line with this vitiated state, that which results from an abuse of the most nutritive aliments.

Strong and black meats, full of extractive matter and osmazome, high seasoned dishes, and fermented liquors, constitute this series, which has the double bad effect of supplying chyle too abundant and substantial, and of over exercising the assimilating power of the stomach. While the man is yet young, and grows in height and thickness, he resists for a length of time any excesses of this kind, especially if he be naturally robust; often even he applauds himself for them, as the strength of his stomach is augmented, and it seems to acquire daily a more considerable digestive power, while his limbs are more fitted for the most violent exercises; the consciousness of his strength inspires him with continual gaiety; every thing is to him smiling, and the future only offers the most flattering images.

This joyous mood is, nevertheless, occasionally interrupted by inflammatory complaints, which are always of the highest degree of intensity—gastro-enterites, pneumonias, cephalites, anginas, ophthalmias, and acute rheumatisms, come on with violence under the influence of heat and cold, or of the passions, make rapid progress, and sometimes terminate in a few days in death. But as all the sympathies are active in youth, crises by hæmorrhages, sweats, and phlegmonous collections, often come to the relief of such persons, in spite of the most incendiary treatment; and we then see them pass, in a few minutes, from appearances of the last agony, to the most complete convalescence.

The appetite is very good at the conclusion of these maladies; convalescents indulge in it, and soon recover a health as vigouros as that which they enjoyed before the phlegmasiæ. This success encourages them; they are persuaded, that they owe their life solely to the energy derived from their succulent food, and fermented drinks; they indulge once more in their use, and many are happy enough to resist frequently such violent assaults. But there is a limit to every thing; to no organized being it is permitted to raise itself beyond the volume and strength of his species. This excess of hæmatosis must necessarily turn to the detriment of the principal organs; and these latter, after having resisted acute congestions, sink under chronic irritations. In fact, the age of consistence has arrived, the activity of the sympathies has diminished, the crises are not so easy; if fresh inflammations come on, they are not completely resolved, especially if they are continued to be treated by stimuli; and there consequently remains irritation in the principal viscera. The impatience to regain their strength, the remembrance of the good effects which they formerly derived from tonics and substantial food, induce convalescents to have recourse to them before irritation is entirely quieted. The stomach is then forced too soon into function; if it be healthy it obeys these stimuli, and all nutrition turns to the profit of the inflammation that remained in the lungs, intestines, &c.: if it be itself the seat of an unextinguished phlogosis, the stomach refuses to digest; it is overexcited, and the disease recommences. But very often, though diseased, it is not so to such a degree as to be incapable of all assimilation; it still digests, but in producing a feeling of suffering. The strength returns in an incomplete manner; a crowd of sympathies is evidenced during digestion, and the person becomes dyspeptic, hypochondriac, and neuropathic. The pristine vigour is not re-established; the health is lost very often for the whole lifetime, though fulness of habit and good complexion be yet preserved for a long period; and this is what distinguishes the morbific effects of good aliments from those of indigestible substances: but so soon as these latter are used in excess, the derangement in nutrition is added to the painful irritation of the viscera, and the persons affected are in the same deplorable state with those whom we described above.

Some individuals, still more fortunately constituted, are proof against the effects of the most substantial alimentation, during the period of their youth; there are even some who pass through their

virile age without suffering from this cause; but it is at the epoch of decline, when about fifty years of age, that disorders await them.

Hence, in the midst of the fullest health, when the muscles are in the most energetic state, when the freshness of their complexion, the warmth of their bodies, the firmness of their flesh, and the most wonderful endurance under extreme exertions, and most unusual excesses, seem to promise them a long and vigorous old age, these persons begin to feel a slight pain in the right hypochondriac region. To this they pay little attention, because it usually vanishes by rest, but it soon becomes troublesome, and gives some uneasiness; their complexion is sallow, their tongue foul, and they complain of a bitter and clammy taste; sometimes they have eructations; their appetite is diminished, digestion retarded, or even their hunger may be great, though digestion be difficult; they suffer from constipation and headach, flushes in their face, and a sensation of fatigue and weight, referred to the limbs; the urine is in small quantity, red and burning. They then have recourse to the advice of a physician. This latter, if an ontologist, pronounces the words *gastric oppression, bilious turgescence, engorgement of the liver;* and he prescribes an emetic, and a purge. Then one of two things takes place; either the copious evacuations produced by the medicine restore for a time the equilibrium, or the irritation is exasperated; and in this case it sometimes passes into the acute state, and these persons have for the first time a pretended *essential (idiopathic) fever;* or at times it remains in a chronic state, but with a degree of intensity greater than before a recourse to the evacuating method. If the patients resume the use of their customary food before the entire cessation of their complaints, the consequence is, that they are never dissipated, and they are in precisely the same state as those of whom we have already spoken. The only difference consists in their arriving at it later, because they were more vigorous. It is now time to extend our researches to the interior of their viscera, in order to discover an explanation of the evils by which they are oppressed.

The slight pain, which they experienced in the right hypochondrium, was an index to the irritation and even latent inflammation of the duodenum, or the superior portion of the jejunum. This irritation acting on the liver forced it to an excessive secretion of bile, which, retained in the superior part of the digestive canal by the irritation that opposed the descent of its contents, and neutralized the action of the large intestine, was brought up into the sto-

mach, tasted in the mouth, and at times, being absorbed, produced jaundice. The pain of the stomach, and of the upper portion of the small intestine, affecting the head, produced in it cephalalgia; the brain being stimulated, rendered the muscles painful,—and all these stimulations conjoined have destroyed the feeling of habitual strength in the individual, and substituted restlessness and sadness. The gastro-intestinal phlogosis disturbed the renal secretion, and rendered the urine of a deep colour, turbid, and in small quantities.

Now, if in this state, in place of bleeding the individual, putting him on regimen, and administering aqueous drinks, we allow him stimuli to his irritated surfaces, why should we be astonished that the latent phlogosis is suddenly converted into acute inflammation?

By the other chance, he is relieved by evacuations, but the irritation is too inveterate and habitual to be entirely removed; and it consequently returns in a chronic form, and even with greater intensity than before. Aliments and tonics are also again given, and they support and exasperate the malady; the sensibility of the alimentary canal is predominant; all the sympathies of the hypochondriasis, the consequence of it, are developed, and life becomes a burthen.

Nor is this all; the liver, so long forced to an excessive secretion by the super-irritation of the stomach and duodenum, contracts a diseased habit, and the patient constantly suffers from bile. This same liver, always irritated, swells and contracts a degree of inflammation, it is surcharged with albuminous, fatty, or adipocirous juices; and unceasingly conveys a feeling of weight and dragging, which is transmitted to the right shoulder. The hypochondrium swells, becomes puffy, inflated, and hot, and we have *obstruction of the liver* joined to hypochondriasis.

Add to these evils the swelling of the mesenteric glands, a necessary consequence of chronic enteritis in lymphatic constitutions; gout or articular inflammations in persons subjected to the action of cold and otherwise predisposed; the colic which succeeds after an indefinite time to gastro-enteritis, and which produces diarrhœa; nephritis, and the formation of calculi, a common effect of vitiated renal secretion, itself kept up by this all-interminable gastro-enteritis; cutaneous inflammations called *herpes;* ophthalmias; diseases of the throat; the propagation of the irritation of the cardia to the left lung, and of the pylorus and liver to the right, whence results phthisis; mental alienation often brought on by hypochondriacal delirium, and we may then have some idea of the terrible effects of

high living and good wine. If to these be added the effects of tonics, bitters, anti-gouty, detergent, purgative, and deobstruent medicines, and finally, the deleterious action of all those indigestible substances of which I have spoken, we shall begin to understand why longevity is of such rare occurrence among the rich, the powerful, idle voluptuaries, and all those pretended epicurians who so readily hailed the incendiary system of the famous Brown.

The stomach may be affected by poisonous as well as by foreign bodies and alimentary substances. Some of the former, such as concentrated alkalis and acids, disorganize it, and, in consequence of the pain thus created diffuse, the irritations through the whole nervous system; afterwards, if death be not the immediate result of this commotion of the sensitive apparatus, inflammation takes place in the membranes of the stomach, and the patient is exposed to all the consequences of this state of things. There are other poisons that do not so rapidly decompose the tissues to which they are applied; they irritate and inflame them from the first, and expose the patient, in consequence, to a disorganization consecutive to the inflammation; these are called *acrid poisons:* others, again, though generally stimulating, produce particular effects on certain organs or apparatus, even though at first applied to the gastric. In this way some produce engorgement of the head: and after having strongly irritated the nerves of the encephalon, bring on sleep; whilst others, such as coffee, keep up the waking state; and others, in fine, like cantharides, exercise a peculiar stimulation on the secreting and excreting urinary organs. It is idle to look on all these as stimulations in which the stomach has no share, and as specific on the organs above mentioned; it is the stomach which receives the primary irritation when these matters have been swallowed, and the stimulation it undergoes may constitute a pathological state. I have, indeed, had an opportunity of observing this effect in a number of persons with an irritable stomach. This viscus suffered as much from the application of cantharides, and the use of wine and coffee, as the encephalic and urinary apparatus; and when these substances penetrate by other ways into the circulation, they still, in cases where death is not sudden and nervous, produce a stimulation of the stomach by which it is rendered one of the chief agents of the morbid phenomena that are manifested. This point will be again brought up when we examine the depurative functions. It is, likewise, to a modification of the stomach and splanchnic nervous apparatus, of which it is the centre, that are owing the principal

symptoms in typhus, whenever gaseous poisons, arising from the decomposition of animal and vegetable matters, have acted on the animal economy. The phlegmasia in such cases begins in the gastric passages, to be thence transmitted, with varied facility, to the other viscera; and we find a similar series of phenomena developed in this as in the cases above described, in which the digestive apparatus is brought into an inflammatory condition by the most substantial aliments and agreeable drinks.

The small intestines always participate, more or less, in the stimulation of the stomach when it has been subjected to the influences of the causes which we have just detailed; but it very often happens, that, like the colon, they are only affected consecutively to the first digestion. We may explain this in the following manner: the stomach assimilatiug its contents imperfectly, allows an irritating chyme to traverse the intestines, in the small ones it only causes uneasiness, but in the large it gives rise to colic, which is only a convulsive contraction of the muscular fibres of this intestine. In this latter the contractions are induced for the purpose of expelling the excrements and stercoral deposit, the presence of which is revolting to the internal sense, otherwise tolerably obtuse; but this double stimulation of the mucous tissue, in which this sense resides, and of the muscular fibres annexed to it, becomes a cause of phlogosis, and colitis supervenes. It is in this way that food the least nourishing and most insipid, which did not sufficiently stimulate the stomach to a display of its assimilating power, and the abuse of autumnal fruits taken with watery drinks, give rise to dysenteries of the most inflammatory nature, such as we meet with towards the termination of the hot season. Erroneously then we do attempt to deduce the nature of the disease from the kind of food, and lay down a corresponding method of treatment. Here, however, we must still make some distinctions.

Insipid food, vegetables, fruits, roots, &c. are received into a stomach, the assimilating power of which they do not solicit; they are badly digested, and retain in part their property of foreign bodies in the intestines, provoking in these latter colics and movements of expulsion. Here we have the diarrhœa of indigestion, the return of which is prevented by tonics, and especially red wine. So powerful is the effect of this drink, that it removes colic, suspends diarrhœal movements, and completes the assimilation of chymous matters which had already passed through the stomach. This is one of those phenomena which have led me to believe, that

digestion goes on in the intestinal canal. This antidysenteric and digestive property of wine, supposes, however two things; 1. that the stomach is not inflamed; 2. that the intestines are all free from phlogosis. But suppose that the food above mentioned, or any other of a more nutritive kind,—the difference is inconsiderable, has been taken by a person predisposed to inflammation, the stimulus of undigested substances will suffice to bring it into action, in one of the three regions of the digestive canal; and wine, opiates, diascordium, in place of checking will increase the diarrhœa, and convert it into dysentery. It is in this way that we meet, every spring, with so many cases. I have made these observations on such a number of subjects as to justify me in giving them as demonstrated; they explain how the same person who was in the practice of curing himself of indigestions by tonics, suddenly finds them converted into a poison, which aggravates his colics, and exposes him to acute gastro-enteritis.

In certain cases, such is the activity of the ingested matters, that the evacuations are singularly accelerated and abundant, and throw the sick into a state of rapid emaciation; sometimes even vomiting is present, and then we have a *cholera morbus* from poisoning. And though the spasms and pains arising from the stimulation of the gastro-intestinal sense are enough to cause death in a short period, yet there is, besides, phlogosis of the mucous membrane in which it resides. With still more reason must this inflammation exist when the patient survives the evacuations, and falls into a state of fever and adynamic prostration.

A default of defecation may likewise become a cause of disease, and always agreeably to that law so important to be remembered, that every undue exaltation of function tends to phlogosis. In the instance now before us, this may be caused as follows: the accumulated fæces solicit the action of the rectum and colon; but as this action is powerless, the redoubled efforts of the fleshy fibres invite more and more of nervous influence, and of blood into the intestinal parietes; the mucous tissue secretes more humours, is heated and phlogosed, and at times inflammation seizes on the entire substance of the organ, and penetrates to the peritoneum. It is thus, that foreign bodies accumulated in the intestines, can, by arresting the advance of their contents, give rise to the most dangerous inflammations. The bladder and genital organs participate to a certain extent in the irritation.

We have elsewhere shown to what a pitch the moral feelings may affect the digestive canal and its appendages.

CHAPTER VI.

OF THE ABSORPTION OF NUTRITIVE SUBSTANCES.

SECTION I.—*A summary Description of the Chyliferous Apparatus.*

THE chyliferous or lacteal vessels, or the lacteal veins, constitute a considerable branch or section of the general absorbent system, which is placed between two laminæ of the mesentery, and terminates at the central trunk of the lymphatic system. In this chapter, proposing to trace the progress of the nutritive materials on to the sanguiferous vessels, we shall join to our description of the particular absorbents of the mesentery, that of their trunk called *the thoracic duct.*

These vessels originate from the mucous membrane of the stomach and intestines, in a manner by us inappreciable, since we cannot trace them to their mouths. We do not know then whether they traverse this membrane, and open on its internal surface, or whether they form pores like the puncta lachrymalia, or a kind of funnels with floating moveable extremities, on the plan of the Fallopian tubes, and are endowed with a vitality capable of allowing them to recognise the assimilated molecules; or whether they are simply lost in the tissue of the mucous membrane, which in this case would absorb the chyle like a sponge, and transmit it to the lacteals.* This last seems to us the most probable method. Be this as it may, the lacteal vessels are in much greater number on the small intestines than in the rest of the canal: they anastomose, and intersect each other repeatedly, without undergoing any change of diameter, like the veins; they go to the mesenteric, mesocolic, and gastro-epiploic ganglions, and finally reach the orifice of the thoracic duct, to be subdivided and anastomosed anew.

The thoracic duct, which is the termination not only of the lym-

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* See Appendix—Observations on General Absorption.—TRANS.

phatics of the abdomen, but likewise of those of the pelvic extremities, and of the left side of the head and neck, begins by five or six large trunks, after which it presents an enlargement called *reservoir of Pecquet*, or *cisterna chyli;* it is situated behind the aorta, and before and somewhat to the left of the second lumbar vertebra This duct passes through the diaphragm, and ascends always on the left side of the subclavian vein, where it curves in an arched form to open by an orifice furnished with a valve, which both prevents the return of the lymph, and the introduction of blood into the duct. Its diameter is from two to three lines: it divides into several branches, which unite into a single, sometimes a double trunk, previous to opening into the vein.

The lacteals, vessels, and the thoracic duct, are composed of two membranes; one external cellular, more solid, very contractile, but not muscular, whatever Schneider and Cruikshanck may have said to the contrary, for we find in it gelatin; another internal, thin delicate, and transparent, which, though *sui generis*, has a close analogy to that of the veins, and forms folds called *valves*.

The lacteal glands are composed, according to certain authors, of a cellular mass, in the interior of which is secreted a fluid destined to mix with the lymph and chyle for their elaboration, and which receives *vasa efferentia*, and gives origin to *vasa efferentia*, (*Malpighi, Morgagni, Cruikshanck;*) while in the opinion of others, these ganglions are only circumvoluted lymphatic vessels, which are thus rolled on themselves, to form these bodies, (*Haller, Albinus;*) finally, some, such as Mascagni and professor Chaussier, maintain that they consist of agglomerations of lymphatic vessels, divided, folded, rolled, and anastomosed without end, and united into a mass by means of cellular tissue, thus forming an organ, which receives many blood-vessels and trisplanchnic nerves, and is enveloped by a tolerably dense cellular membrane. Their volume varies, according to authors, from the twentieth part of an inch to an inch in diameter; but we suspect this last mentioned size to be always indicative of a pathological state. Their colour is, in general, reddish, sometimes gray or dark, which latter, also, seems to us to depend on a state of phlogosis. They are enclosed in a dense and externally shining membrane, and enjoy great vitality.

Section II.—*Of the Functions of the Chyliferous Apparatus.*

Absorption in the gastro-intestinal mucous surface is, according to our view, performed by the laws of vital affinities or vital chemistry, which, with a modern writer, I willingly call *organic*. This phenomenon is of the same order as assimilation, to which it is the sequence. It is true that absorption takes up a number of molecules not assimilable, but this is still accomplished by the aid of those that are so, and on the express condition, that the foreign molecules shall not give rise to a too lively excitation; otherwise, this latter state, by arousing the activity of the gastro-intestinal sense, would excite the muscular coat to contractions, the tendency of which would be at least to expel the offending bodies. Hence the opinion of Bichat, who taught that a peculiar organic sensibility, which he calls *elective* as opposed to the introduction of whatever is not adapted to the wants of the animal economy, is only to a certain extent correct. A great number of aromatics, medicinal, and even poisonous substances, enter into the absorbent vessels, and would seem to have obtained admission only for the purpose of being promptly eliminated through the various emunctories. The organic sensibility is then far from being an incorruptible sentinel; it is much less delicate than the internal senses, and wo to him who neglects the advice of these latter. The absorbing surfaces are, on the contrary, very greedy, especially when the want of restoration in the system is decidedly felt; they admit the useless, the superfluous, and even hurtful, leaving it to to the efforts of the animal economy to expel them by the depurating organs. The only limit to the exercise of the absorbing power is in the super-irritation or extreme fulness of the vessels. It even often happens that particles which are not too irritating to the absorbing orifices, become excessively so to the tissues to which they are brought by the circulation, and give rise to a phlogosis in the secreting organs. Among these is cantharides, which does not invariably irritate the mucous coat of the digestive canal; and also mercury, and many poisons, which that surface, too eager for materials to act on, does not always refuse to absorb, whenever the will has overcome the repugnance of the senses of smell and taste to those substances.

So soon as the absorbed matters have reached the chyliferous vessels, they cease to be under the influence of organic chemistry; because they are then no longer presented molecule by molecule, to be insinuated into those of the living tissues; they thenceforward

form masses, and as such they must receive their progressive impulsion from contractility. These small columns of chyle are now driven towards the centre of the mesentery by the contraction of the lacteal veins, and the valvular plaits are in mechanical opposition to their retrograde movements. Thus it is that the laws of matter are continually associated with those of life in the performance of the functions of the animal economy.

But does contractility always preside over the motion of the absorbed fluids, when they have reached the tissue of the lacteal ganglions? Proof derived from the aid of our senses here again fails us. It is in vain to tell us that the glands under consideration are collections of vessels folded or rolled on each other, when no preparation furnishes us with the proof. For myself, who do not admit the division and subdivision of vessels without end, I cannot suppose that such is the structure of the ganglions. I infer, on the strength of reasons which I shall adduce when treating of the capillary system, that the above mentioned organs are small parenchymæ, in which sanguineous lymphatic vessels are lost, and deposit their fluids, which are again taken up by other vessels, to be reconveyed into the circulatory stream. It seems to me probable, upon this account, that the vital chemistry acts for a moment on these fluids, and that they only come under the influence of contractility as a propulsive force when they are disengaged from the ganglionic parenchymæ. I shall doubtless be asked, of what use is this momentary extravasation; that is to say, of what use is the lacteal ganglions? I am reduced to inductions in order to reply to this question; but, as I am of opinion that they will be better placed in the account of general absorption, I refer to that chapter, and follow the course of the chyle in its progress towards the blood-vessels.

The reservoir of Pecquet and thoracic duct call into play merely the contractility of their coat, which is considerable, for the purpose of conveying the chyle, or in its place the lymph, into the left subclavian vein; and the aid of the valves, always necessary for diminishing the weight of the column, by dividing it into numerous sections, is enlisted until the moment in which the fluid has reached its destination.

Section III.—*Of the Diseases which result from the Action of the Chyliferous Apparatus.*

These diseases are few in number. Phlogosis of the thoracic duct has never been observed, perhaps because due attention has

never been paid to the subject; nor do we find that irritating fluids, which incessantly traverse the chyliferous vessels, ever produce in them inflammation. We can, however, conceive the possibility of this phenomenon, especially in the coats of the thoracic duct; it must exist in certain cases of peritonitis, and of phlegmasia of the cellular tissue of the abdomen and thorax. But have the peculiar symptoms ever been distinguished from those accompanying such diseases in general? It would be natural to suppose, that this inflammation must be opposed to nutrition, especially when concretions and obstructions are formed in the thoracic duct, or when it is compressed by some tumour; but cannot life still be supported by venous absorption? Have we any proof, that the lacteal vessels of the mesentery do not communicate with the veins of the intestines? Doubtless the chyle, formed out of solid aliments, does not take this course; but in acute diseases hardly any solid food is taken; watery drinks suffice for nutrition, and we now-a-days admit that water may enter into the venous without following the longer route of the lymphatic system. We hence find it very difficult to assign to the coats of the chyliferous vessels their part in the etiology of diseases.

Such is not, however, the case with the ganglions of the mesentery, and it is an additional reason for believing that their structure and functions are essentially different from those of the lacteal vessels. These small parenchymatous bodies are endowed with great vitality, and while it is impossible to discover any sympathy between the lacteal vessels and the rest of the body, we observe very active ones between the mesenteric ganglions and the gastro-intestinal mucous surface. This discovery belongs likewise to the physiological doctrine, which has shown that all gastro-enterites are accompanied by a tumefaction of the mesenteric glands. Notwithstanding that chyle may be charged with acrid, irritating, or even poisonous matters, they traverse the ganglions with impunity, provided they do not inflame the gastro-intestinal mucous surface. Our attention has been for a length of time directed to this question, and we have not observed any instance of mesenteric ganglionitis which had not been preceded by well-evidenced gastro-enteritis.

It is worthy of remark, that the swelling, or, as we commonly express it, *obstruction* of the mesenteric glands, offers no obstacle to the absorption of chyle. In fact, whatever may be their disorganization, we never observe diarrhœa, unless the inflammation has passed the ileo-cœcal valve. Hence we are justified, in cases in

which the inflammation has extended into the large intestine, in affirming that diarrhœa does not proceed from obstructed mesenteric glands, but that it depends on the phlogistic irritability of the colon not allowing it to bear the presence of fæcal matter, nor, as in common states, to serve for their deposit. The persistence of absorption in despite of the engorgement of the lymphatic glands, seems to us explicable by the numerous anastomoses of the lacteal vessels; for the ganglions are never all affected at the same time, and the chyle, diverted from those that are diseased, still finds a ready passage through others which have preserved, their normal or healthy condition. As to the examples met with in acute affections, in which all the ganglions are presumed to be inflamed, their intensity is such, on account of the violent gastro-enteritis, that all the functions are inverted, and all the *ingesta* powerfully rejected, as well by stool as by vomiting; but such a state of things during any length of time is incompatible with life. Of this nature is yellow fever, in which all parts of the alimentary canal are a prey to the most dreadful of inflammations, which is afterwards repeated in the other visceral cavities. Death cannot here be referred to a defect of absorption; but it is rather the consequence of the sufferings and rapid disorganization of the principal sources of life. I have likewise met with general chronic phlegmasiæ of the digestive tube, and have always observed that they kept up a constant diarrhœa, or were opposed to every kind of ingestion: but in this case death was not the effect simply of an obstacle presented by the ganglions to the absorption of nutritive materials; for besides that the colon was irritated, the veins could have introduced a sufficiency of water into the circulation to keep it up, and give time for the inflammation to subside, as happens on many occasions. We may hence lay it down as a general principle, that in partial gastro-enterites there are always ganglions enough to allow of the absorption, even of chyle formed out of solid food; and thus that when diarrhœa is added to these other diseases, it is not dependent on the obstruction of these bodies, but simply on the colon having become too irritable to admit of the accumulation of fæcal matters.

From these considerations it follows, that the affections of the ganglions of the mesentery are always of secondary importance in the causes and symptoms of diseases, and we deem it on this account useless to dwell any longer on the subject.

CHAPTER VII.

OF THE CIRCULATION OF THE BLOOD.

So soon as the chyle has been poured into the subclavian vein, it is carried with the blood by the current of the circulation, and reaches with it all the different parts of the body. It is therefore with the circulatory movement that we shall now occupy ourselves.

The apparatus of the circulation, according to most authors, is composed of the heart, its centre and *primum mobile;* of the arteries, which convey the blood into all the tissues; and of the veins, which bring it back to the heart, whence it issues anew to begin again the same course: but at the termination of the arteries the parenchymæ of the organs are found, which it is necessary for the blood to traverse, before being taken up by the radicles of the veins. This is what Bichat has called the *capillary circulation.* The circulation ought therefore to be studied in the heart, in the arteries, in the parenchymæ of the organs, and in the veins, inasmuch as the blood is subjected to the action of different forces in these parts.

Section I.—*Description of the Heart.*

The heart is a fleshy mass, formed of fibrin eminently contractile; it is hollowed out into four cavities, two of which receive the blood from the veins, and force it into the two others, which drive it through the arteries.

The heart is situated in the midst of the thorax, in an envelope called the *pericardium*, behind the sternum and the cartilages of the sixth and seventh left ribs, and between the two laminæ of the mediastinum, before and below the lungs. It is placed obliquely; for, whilst its base rests on the vertebral column behind, its body is inclined towards the left, from behind forwards and from above downwards, so that its apex strikes the cartilages of the sixth and seventh ribs of the left side. This organ is connected, in front, with the pleura, the thymus gland, the sternum, and the cartilages of the ribs before-mentioned; behind, with the bronchia, the œsophagus, and the descending aorta; upon the sides, with the left mediastinum and pulmonary pleura, and with the phrenic nerves;

below, with the phrenic centre. Its form is that of an irregular cone, a little flattened from before backwards.

When we examine the heart, the first object that engages our attention, is its envelope. The *pericardium* is composed of two membranes; the external one is fibrous, closely connected with the diaphragm below, and more or less extended upon the origin of the vessels that issue from the base of the heart, which it encloses without adhering to it; the other lamina lines the preceding one, from which it is reflected upon the origin of the large vessels, and upon the heart itself, in such a manner as to form a perfect sac without opening, the external surface of which adheres closely to all these tissues, whilst the internal is without any adhesion; it is continually lubricated with a lymphatic vapour, intended to facilitate motion, and which has induced Bichat to class it among the serous membranes.

On opening the pericardium the heart is perceived covered with this coat, which gives it a smooth and polished surface. The four cavities of the heart are: first, the right auricle, situated at the fore part of the base, and a little to the right; its walls are very thin, and we find in its interior, backwards and above, the orifice of the vena cava superior; below, the Eustachian valve; inferiorly, and to the right, the opening of the vena cava inferior; within, the partition which separates it from the other auricle, in which is the fossa ovalis, occupying the place of the foramen of Botalus. Secondly, the right ventricle, forming the anterior and right side of the heart, is in apposition with the left ventricle; its form is that of a triangular pyramid, the base of which is from above downwards; in its interior, are fleshy columns, more or less strong; it has at its upper part two openings, viz. (*a*) behind, that orifice which communicates with the auricle of which we have just spoken, and is named the *auriculo-ventricular orifice;* it is provided with the triglo-chine or tricuspid valve, having a direction towards the internal part of this ventricle; (*b*) before, the orifice of the pulmonary artery, furnished with the semilunar or sigmoid valves, opening towards the interior of this vessel. Thirdly, the left auricle occupying the posterior and left part of the heart, receiving backwards and above the four pulmonary veins, as the right receives the two venæ cavæ; it is as thin as the right auricle, and presents nothing remarkable in its interior. Fourthly, the left ventricle, situated at the posterior and left part of the heart, is much thicker than the right, possessing also the fleshy columns, which,

however, are much stronger; and having at its base an auriculo-ventricular opening provided with mitral valves, which stretch forwards into its cavity: it is situated behind the orifice of the aorta, in which are found the sigmoid or semilunar valves, directed towards the interior of this vessel.

All these cavities are lined by a smooth transparent membrane, analogous in its nature to the serous system: it is continued from the right side with those of the venæ cavæ and pulmonary artery; from the left with the pulmonary veins and the aorta, and is reflected over the valves of all the orifices.

The heart receives two arteries called coronary, which are given off from the aorta, beyond the semilunar valves, and two veins which empty their contents into the right auricle. Its nerves are derived from the cardiac plexus, which is formed principally, as we have seen, by cords of the great sympathetic, but where also terminate many filaments of the eighth pair.

We see going off from the pulmonary artery, after its division, a ligament which attaches it to the aorta; this ligament is nothing else than an obliterated canal, but which formed before birth the principal trunk of the artery, of which the pulmonary were then nothing but insignificant branches. When we come to consider the fœtal circulation, we shall see the use of this trunk, which bears the name of *ductus arteriosus.*

Section II.—*Of the Functions of the Heart in the Adult.*

The right auricle receives by the superior vena cava the blood which returns from the head and thoracic muscles; and by the inferior vena cava, that which has circulated in all parts of the body, except the lungs. Now, when on the subject of respiration, we have seen that the blood loses its vermilion colour in contributing to the exercise of the different functions of the organs; it is then with black blood that these right cavities are in contact. The left auricle receives from the pulmonary veins the blood that has been submitted to aeration, and the colour of which has been restored in traversing the parenchyma of the lungs. It follows that the two left cavities act constantly on the red blood; nevertheless the two sides of the heart are far from having an unconnected action. The two auricles act together, and alternately with the two ventricles, the contraction of which is also simultaneous. In fact, the blood enters the right auricle by the two venæ cavæ, and into the

left by the four pulmonary veins, at the same time. It dilates these auricles, which were in a relaxed state, but immediately they cause it to pass through the auriculo-ventricular orifices, the inaction of the latter corresponding with the contraction of the former. The ventricles are no sooner filled, than they contract in their turn, and propel the blood through the pulmonary arteries, and through the aorta, at the same moment in which the two auricles dilate anew to receive that of the vena cava and pulmonary veins. Thus the motion of the dilatation of the auricles, corresponds to that of the contraction of the ventricles, and *vice versa*.

The contraction of the four cavities of the heart is produced by the shortening of their fleshy fibres, a process which tends to condense this organ, by approximating the walls of its four cavities to their common centre, that is to say, the auricles to the base of the ventricles, and the ventricles to the base and opening of the auricles. It follows then, that if the triglochine and mitral valves were not depressed and applied upon the auriculo-ventricular openings at the moment of the contraction of the ventricles, the blood of these cavities would be regurgitated into the auricles; but this depression of the valves prevents such an effect; and as the sigmoid valves open in an opposite direction, they yield and give free passage to the blood which is forced through the trunks of the aorta and pulmonary arteries. When, afterwards, the relaxed ventricles cease to compress these last valves, the blood with which the arteries are filled, having a tendency to flow back to the heart, raises and forces them to close up the orifice of the ventricles, thus opposing an insurmountable barrier until the moment when a new wave of blood pouring from the heart again depresses them and forces for itself a passage.

The pulsatile motion of the heart against the sides of the thorax takes place when the ventricles contract or shorten themselves, and is occasioned by the simultaneous dilatation of the auricles, and of the pulmonary artery and aorta, which throw the heart forwards.

Section III.—*Fœtal Circulation.*

The radicles of the umbilical veins take up the blood in the placenta: this vessel conveys it, on the one part, into the vena porta; on the other, into the inferior vena cava, which, after having received the hepatic veins, deposits the blood in the right auricle, from which it passes by the foramen of Botalus into the left auricle,

and is thus diverted from the right ventricle, and consequently from the pulmonary artery. The blood of the superior vena cava remains in the right auricle, because the Eustachian valve is applied against the foramen of Botalus, until it is passed into the right ventricle. But, when this latter by its contraction forces the blood into the pulmonary artery, the ductus arteriosus of which I have spoken above, and which now constitutes the principal branch of this artery, turns it into the aorta, and thus forms the second diversion made from the lungs, which receive blood only by the two branches of the pulmonary artery, (always of small size in the fœtus,) and by the bronchial arteries. We perceive that this arrangement is founded upon the absence of the functions of the lungs; it would be entirely useless for all the mass of the blood to traverse these organs, since respiration does not exist. But, in proportion as the time of the birth of the fœtus approaches, the circumstances favourable to this deviation, such as the size of the foramen of Botalus, and of the *ductus arteriosus*, are lessened; and finally, after birth, these openings are obliterated, and the circulation is carried on in the manner before described.

Section IV.—*Of the Arteries.*

The arteries may be compared to two hollow trees, having their trunks implanted into the base of the heart, and sending forth their branches and ramifications, the one into the lungs, and the other into all parts of the body.

The first, called the *pulmonary artery*, arises from the right ventricle, and soon divides into two branches, each of which is ramified in the lung of the same side; the second, which is called the *aorta*, is the origin of all the other arteries, and the support of the general or *great circulation:* this artery presents a number of peculiarities to the observer.

In the first place, the aorta, after rising above the base of the left ventricle, makes a curve upon the left side of the vertebral column, and forms what is called *the arch of the aorta*, from which are given off large arteries to the head, encephalon, face, neck, larynx, trachea, lungs, (the bronchial arteries,) and the superior extremities. Afterwards the aorta, descending always upon the left side of the body of the vertebræ, traverses the thoracic cavity, where it is confined to supplying branches to the skeleton and the parts which cover it; next it perforates the diaphragm, descends upon the ante-

rior part of the body of the lumbar vertebræ, is then called *abdominal aorta,* and furnishes arteries to all the viscera of the abdomen and genital organs; finally, having arrived at the lower part of this cavity, it divides into two branches called *primitive iliacs,* each of which passes to the inferior or pelvic extremity of the same side in order to nourish all the tissues, even to the extremities the farthest removed from the heart.

Such is the general plan of the distribution of the arteries, and the origin of all the branches that we have mentioned, in speaking of each organ in particular.

The arteries appear as cylinders, which lose none of their volume until they furnish other cylinders smaller than those from which they were themselves given off. These separations are made at different angles, from a right to the most acute. The terminating branches are so small, that they have been compared to hair, hence the name of *capillary arteries;* and either continue into small veins, or are lost in the tissue of the organs.

For us to say more on the distribution of these vessels, would be to undertake a treatise on anatomy; we shall therefore proceed to the consideration of the structure, properties, and functions of the arterial system.

Section V.—*Structure of the Arteries.*

After having greatly multiplied the coats of these vessels, anatomists have come to the conclusion to acknowledge but three. The first is the *external* or *cellular,* which is most abundant in those parts where the arteries are not supported by any tissue. This coat is gelatinous, extensible, and so much the less dense as it is external to the arterial canal, for which it forms a real sheath. The second is the *proper coat,* composed of circular, transverse, yellowish, elastic fibres, with little extensibility; it is formed of fibrin, which differs one hardly knows how from that of the muscles;* it appears red in the small arteries, owing to their thinness permitting the colour of the blood to shine through. The third coat, or the *inter-*

* So far from the proper coat being formed of fibrin, chemists are not agreed as to the presence of any of this organic element in the arteries. Berzelius assures us that it cannot be found in them. The proper arterial coat consists, as the author has himself elswhere said of yellow elastic fibrous tissue, and exhibits all the properties of this tissue.—Trans.

nal coat, which some anatomists have gone so far as to divide into two laminæ, is thin, smooth, and transparent, always moistened with a reddish serum, and has been compared to the serous membranes. Whatever may be said, these two last have no analogy to any others in the body; they are *sui generis,* particularly the proper coat, which it would be very erroneous to compare to any portions of the fibrous tissue.

Vessels may be distinguished in the cellular or external coat of the large arteries; but it is impossible to follow them into the two others: with regard to the *vasa vasorum,* we have no means of accomplishing their dissection. This same cellular coat also receives nerves; they are small and few in the arteries which are distributed to the organs under the predominating influence of the brain; but the splanchnic arteries are, as we have already seen, enveloped by large plexuses of nerves, especially in the viscera of the abdomen.

Section VI.—*Vital Properties of the Arteries.*

As the external or cellular coat possesses properties common to the tissue, which, as well as it, are formed of gelatin arranged in areolar laminæ, we do not think proper to dwell on it here. Contractility is extremely obscure in the internal coat; but extensibility is very remarkable, since it can form hernia, in certain aneurisms, through the rents of the proper coat. It is particularly with the properties of this last that it is important for us to occupy ourselves.

The quality which has most engaged the attention of anatomists in the coat in question, is its elasticity. Some persons wish to make this merely physical, comparing the arteries to some inorganic bodies, which restore themselves to a certain state of equilibrium, when they have been stretched by the action of an external force. In our opinion, this property considered in the arteries, is altogether vital. In fact, it belongs to the particular composition of the fibrin of their middle coat, a composition which is itself the production of vital or organic chemistry, and which is intended for uses purely vital. That hardness, density, weight, extensibility, relaxation, elasticity, softness, flexibility, &c. do exist in organized as well as in unorganized bodies no one can doubt; but I cannot perceive what science can gain by the physiologist separating these properties from the tissues of living beings, to consider them as phenomena pertaining to matter; for in fact these same properties, which serve a purpose altogether physical in inorganic bodies, have

an object entirely vital in organized ones. I see here but one point of resemblance between bodies which have life and others which have not. But as these qualities are subservient to a physical state in the latter, so they are adapted to a vital one in the former; they are its work, and form part of its history. That they should be compared in the two classes of bodies, is I believe necessary, and even indispensable; but for any one to isolate living, and to compare them to inert bodies, appears to me to be as incorrect, as if a person should do exactly the contrary, and consider, for example, the elasticity of water, and that of gas, as properties borrowed from living bodies. It is thus, in my opinion, of colours, forms, size, &c. qualities that are equally the property of all natural bodies.

I consider then the elasticity and the retraction of arteries as vital properties, bestowed upon them by creative power, exactly in the degree necessary for a due performance of the functions of those vessels; these are nothing but contractility; and this property, though retarding for some time the destruction of the vital power, is not less the production of this latter, and has been bestowed upon these parts only to concur to the preservation of an organized and living being. It is this that we propose soon proving in studying the functions of the arteries.

Though contractility exists in the coats of these vessels, they have no sensibility in a natural state, at least there is none in those of a certain size. Certainly it could be developed in them by inflammation, but even then it is so very obscure, that pathologists have not yet been able to deduce from it the diagnosis of arteritis. It is probable that the pain might be perceived in the tissue of the arteries; but it is necessary for this, that other sensations should not predominate to absorb the attention of the percipient centre. Now, that is scarcely possible; for the attacks of acute arteritis, which are the only ones that can cause pain, are generally accompanied by other irritations much more active.

Section VII.—*Of the Functions of the Arterial System.*

The arteries, examined from the heart on to the capillary system, are organs which have little influence in the circulation; yet they contribute something to it; being always filled with blood, they are suddenly and all at the same time agitated by the wave of this fluid, which the heart throws into the common trunks at the moment of its systole. In examining them with much attention in

those parts of the body where they are superficial, we remark neither dilatation nor contraction; the middle coat is that which is vibrated by the percussion of the blood in its whole extent, and which reacts against it from its elasticity or the degree of contractility belonging to it. This reaction cannot fail to communicate a new impulse to the blood, although it may be very difficult to appreciate it. When, in that species of aneurism called *varicose*, the blood passes directly from an artery to a vein, this latter presents pulsations; but they are weak, and are diminished more and more as the vein becomes dilated, because the walls of the latter, not being elastic, cannot drive back the blood, nor preserve the natural dimensions. We can judge by this of the very important duty of the middle coat of the arteries. In fact, were they susceptible of prompt and entire contraction, which would suppose them as irritable as the splanchnic muscles, the arteries would contract when the action of the heart was arrested, as for example, in syncope; and when this organ would again be excited to action, there would be strangulations similar to those observed in the digestive canal. If they were more dilatable, they would enlarge beyond measure every time that the course of the blood is greatly accelerated, which would render aneurisms as common as they are now of rare occurrence. On either of these two suppositions, we would find at every moment partial contractions and dilatations taking place in these vessels, and existence would be continually jeopardized. In truth, the arteries are dilatable, and contract even to obliteration; but for this effect to take place a long time is requisite. True aneurisms, or the dilatation of all the coats of the artery without rupture, require long and powerful efforts; and obliteration takes place only when a portion of an artery is void of blood, and even then there is formed in the vessel a clot, which is not removed so as to permit the close approximation of its walls, but after a great length of time. We perceive that nature has ordered it well in the composition of the arteries; she wished that their middle coat should be sufficiently contractile to repel the blood, but not enough to obliterate suddenly the diameter of these vessels. This coat is to keep them always open, and to prevent their closing until they have become entirely useless. There is not found any other tissue charged with exactly the same functions; nor does there exist in the animal economy any which can be compared to this one; for which reason we have asserted that it is *sui generis*. It is formed of fibrin, it is true, but of fibrin in a particular condition. We may

call it *muscle* if we please; but it will be necessary to grant that it is muscle such as can no where else be found.

We have elsewhere said that the arteries participate in the vitality of the tissues in which they are met with, and we ourselves rest our assertion on the nerves that are distributed to those vessels. The changes which they undergo in their size, when the organ in which they are situated exhibits an unusual degree of vital action, or is the seat of inflammation, are independent of the impulse of the heart; but this is only observed in the branches, ramifications, and minutest divisions, which appear to enjoy a much greater degree of vital action than the large trunks. It is very difficult to determine how far the coats of the small arteries are susceptible of inviting the blood during the sympathetic influence of the viscera on each other, and also of measuring the degree of action that the internal sensitive surfaces, (mucous membranes,) and the secreting or erectile organs can communicate to those vessels which convey the blood to them. We cannot form to ourselves any definite idea of the part that the nervous extremities play in the capillary arteries. But it is conjectured that the middle coat, at this degree of tenuity. is blended with the nerves, and rendered by their presence much more irritable than it is in arteries of a certain size.

Section VIII.—*Of the Capillary Circulation.*

It is to Bichat that we are indebted for having called the attention of physiologists to the capillary circulation; for, notwithstanding the assertion of Stahl, who taught that the blood was regulated less by physical than organic laws, and the experiments of Pierre Antoine Fabre, which prove that the blood in the capillary system moved frequently in an opposite direction to that given it by the heart, this viscus never ceased to be considered as the sole mover of the circulation. The majority of anatomists professed that the arteries were converted immediately into veins, and took no account of the modifying influence exercised by the muscles and the different secreting organs, upon the movement impressed by the systole of the heart.

The capillary system, agreeably to modern authors, consists of a class of vessels extremely delicate, joined together in innumerable anastomoses, and forming a continuous net-work, intermedial between the arteries and the veins. These vessels, add the authors who admit the capillary circulation, enjoy a peculiar action, which

does not depend on the impulse of the heart; they are not always and every where equally filled with blood, as should be the case if this fluid was only regulated by the uniform action of that viscus alone. How otherwise will this action be preserved constantly the same? Does not the sum of the middle arteries exceed very much in volume that of the larger trunks? Whence it results that the space traversed by the blood is continually enlarged. Besides, the coats of the arteries, becoming more flexible in proportion as they decrease in size, cannot drive back the blood by a shock as forcible as that impressed upon it by the larger arteries, which cannot fail to weaken the impulse of the heart. Finally, the blood, reaching the capillary system, meets with much more ample space, and greater flexibility, and it is there that the pulsatile movement of the heart is destroyed; so that the molecules of the blood would only be propelled by those coming after them in a slow and weak manner, if no other force intervened to hasten their motion and cause them to arrive at the radicles of the veins.

It is here that the vessels forming the capillary system, and which are neither arteries nor veins, play, according to authors, a very considerable part; they receive, by the nerves that penetrate them, partial stimulations which derange this monotonous regularity of action; and the blood forcibly invited to certain parts by the irritation, deserts others without the action of the heart being disturbed; or else, finding an obstruction in some point, it is diverted from its course, by means of the anastomoses, to flow into the adjoining parts, and even retrogrades, if it is necessary, rather than accumulate in excess before the obstruction that is opposed to it.

All these observations relative to the diversion of the blood are very correct; physiology and pathology continually furnish confirmation of them. The experiments of Fabre, repeated by Dr. Sarlandière, on the mesentery of frogs, experiments of which I have been an eye witness, afford a direct proof. We have seen in these experiments the blood and all the fluids rush, for some moments, towards the point irritated; and when they were congested there, we have remarked that the globules took a different direction, and even traversed the vessels that conveyed them in an opposite course, and some seconds after we have observed them to return with as much rapidity to the point from which they had been repelled.

There is no doubt that similar variations take place in the movement of the fluids in man, on the occasion of an increase of action

in the secreting organs, in the muscular fibres of every kind, in the skin, and in the viscera, whether under the influence of the passions, or in the orgasm inseparable from the exercise of their functions, or finally in their inflammations. It appears to me unavoidable that, during the chill that designates the commencement of visceral irritations, continued or intermittent, the blood should be invited towards the internal organs and there accumulated, and should then be diminished in quantity at the surface. No doubt that, the congestion once formed, the blood may be more or less driven towards the other parts of the capillary system, and that frequently it traverses, in an opposite direction, the arterial vessels that had conveyed it there, and the veins which carried it back to the centre.

It is not only from the interior to the exterior that these differences are observed; we see great irregularities in the quantity of blood that is found in different parts of the skin, and in those of each viscus, considered separately. It is thus that anger, shame, and modesty, suffuse the face without having the same effect on the extremities; that the act of digestion invites the blood successively into the stomach, the duodenum, the liver, the small intestines, and the colon. Do we not frequently observe in the bodies of those who sink under partial gastro-enterites, a vivid redness about the inflamed point, whilst the surrounding parts are deprived of blood? And if the inflammation has been of long duration and travelled the whole canal, the parts most recently affected contain a great quantity of blood, whilst those that have been the first disordered appear empty, although they still present unequivocal remains of inflammation, such as thickening, ulcerations, and suppurations. When the inflammation, after having existed a long time in the mucous membrane of the intestines, attacks the peritoneal surface, the blood follows it, and the serous membrane appears filled with this fluid, whilst the mucous, although remarkably disorganized by the previous inflammation, contains none. But we can only observe this in subjects exhausted and rendered almost exanimate by the duration of the disease or by hæmorrhages; for the plethoric have always sufficient blood, to allow all the parts adjoining the centre of inflammation to preserve a notable redness.

M. Sarlandière in his memoir on the circulation, published in the first volume of *Annales de la Médecine Physiologique,* remarks that the retrograde movements of the blood, of which we have just

spoken, do not take place in the vessels adjoining the heart, or even in any vessel of a large size; and that we can only perceive them in the small vessels, as in those that approximate nearest to the capillary system; but he observes, that at this degree of diminution the veins and arteries afford examples of them.

It is in the coats of these vessels which form according to them, the capillary system, that modern anatomists and physiologists locate the vital action which gives these various directions to the blood that traverses it; hence the opinion, that these coats, which are inert in the large arteries, or which at least act only by a vital elasticity always the same, become so much the more energetic as the vessels are smaller; so that the most exalted degree of activity is met with precisely in the capillary system.

I concur with them in the opinion, that the small arteries are more active than the large ones, and that they participate in the excitations received by the nerves which are blended with their coats (R). I think that this arrangement renders them susceptible of participating, to a certain extent, in the physiological modification of the organs of which they form part. This appears to me to be proved in their enlarging so remarkably in the seat of inflammation, and the return to their natural dimensions after this is resolved. I believe, also, that the smaller arteries, in a state of inflammatory excitement, transmit the same modification to others situated in a part which sympathises with that in which they are found; but I cannot admit that the capillary system consists of nothing but vessels; for, since it is proved that fluids penetrate every where, to say that the blood is always enclosed in these vessels, is to assert that the body of animals is altogether vascular, which is repugnant to our belief. Undoubtedly there is a capillary net-work which penetrates all parts; but when these capillaries have reached a certain degree of tenuity they disappear, and the blood they contained is actually extravasated. It circulates in the interstices of the fixed animal matter, (which is every where porous,) no longer in large masses, nor even in small columns, but molecule by molecule, in immediate contact with those of this matter; and it is there that the phenomena of nutrition, composition, and decomposition, must take place; and there also is verified, as respects living bodies, the axiom of the chemists: *Corpora non agunt, nisi sint soluta aut fluida.* It is by the successive diminution of the filiform structure that nature accomplishes this purpose, and we may con-

ceive the last can no longer be organized coats, themselves containing other vessels. A glance at the different orders of animals ought to throw some light on this question.

The lower orders of animals, such as the infusoria, and the polypi, afford no evidence of vessels. They are formed altogether of a homogeneous and porous animal matter, always identical in its organization, whatever may be its size. It absorbs and admits into its interstices the nutritive materials; it appropriates them, throws off the superfluous part, and secretes its calcareous phosphate, without requiring the aid of vessels or nerves. Behold here the type of the parenchymatous system, or of the proper tissue of the organs: it is from this that it is necessary to set out, in order to form an idea of the circulation.

So soon as the mass of animal matter is charged with other functions than that of assimilation, or rather when nutrition requires complicated acts, and spontaneous generation is met with, vessels and nerves exist. There is in worms a central vessel that traverses the whole length of the animal, and which sends forth branches into the different parts of the body, and a nervous apparatus to direct the action of this vessel; but we find here no evidence of a heart.

The fluids are conveyed from the digestive canal into the vascular receptacle, and from this into the animal tissue not vascular. We know not if this last returns them to the receptacle; but still it is certain that the greater part of the animal is not vascular.

The vessels are very short, and we see them, soon after they arise from the great vessel of deposit, pour out their fluid into this living tissue, which may be compared to that of the polypus, and which forms, I repeat it, the greater part of the bulk of the animal.

In the mollusca a heart is found with only one ventricle; but the vessels which arise from it are by no means numerous; so that gelatin or albumen not vascular, forms still the greater part of the animal, and alone secretes the calcareous phosphate; for certainly, the snail and the oyster have no more need of vessels to secrete their shell, than the polypus has to form its coral.

In insects we find more complexity; nevertheless we are assured that the vascular system is here very limited, and that the animal matter without vessels is still in a large proportion.

As we rise in the scale, animals present more varieties in their different parts, and more complexity in their functions, and the vascular system and the nerves are multiplied in the same propor-

tion; these, however, are still so trifling in fishes and reptiles, that their circulation cannot save them from death, if they be exposed to a degree of cold amounting to freezing. We may then affirm, without fear of being deceived, that the greater part of the mass of these animals is not vascular, but consists, like that of the polypus, of animal matter, in the interstices of which the fluids move without the aid of arterial or venous coats. These vessels terminate after having there poured out their contents, and the organic action of the molecules, which are not vascular, causes them to undergo alterations, and alone impresses upon them motion, until they are taken up by the radicles of the veins: a heart with only one ventricle, and remote from the parts in question, could assuredly exert no influence over this kind of progression.

Finally, when we arrive at warm-blooded animals, the vessels are multiplied; the heart is very vigorous; it has two ventricles, and its impulse is strongly felt far into the vascular system: all this apparatus is supplied with particular nerves. But is this equivalent to saying, that the heart alone presides over the movements of the fluids, or even that, where its influence ceases to be felt, it is always supplied by that of the coats of the capillary vessels? Certainly not. The rudiments of animality, the parenchymatous matter, analogous to that of the polypus, never disappears; it is that which forms the proper tissue of every organ. Undoubtedly it is found in this class more varied in its forms than among animals of a lower grade; but this difference is still not so great as we should at first sight be induced to believe. Are not gelatin, albumen, and fibrin, the basis of all our tissues? and are they not formed equally in the mollusca and in fishes? Fibrin perhaps is wanting in the polypi; but mucus and gelatin are found in them; and we know that fibrin is nothing but a degree of improvement of these two forms, which belongs to animals more elevated in the zoological scale. With respect to the different forms of animal matter afforded by the secretory organs, such as milk, bile, saliva, &c. they proceed from the three primitive ones; and, if these do not need vessels for their existence in the animals of the lower classes, wherefore do we make this aid indispensable in the mammifera? The vessels are destined to convey nutritive materials; but when they have poured them out in their tissues, they doubtless disappear. What signifies our admitting this multiplication of vessels *ad infinitum?* That those of a certain size contain others in their walls; that even these latter, when they are sufficiently large, contain others of a

third class, is comprehensible; but that there is no limit to this multiplication is a thing that cannot be admitted. I believe even that it does not extend very far, and that, in many organs, the vessels terminate abruptly, depositing their fluids between the molecules of the primitive tissue, whether it be gelatinous, albuminous, or of fibrin. This appears to me to take place in the white pulp of the brain, and in the tendons, ligaments, bones, and even muscles. With regard to the lungs, liver, spleen, and digestive canal, they are undoubtedly much better supplied with vessels; but these latter themselves, becoming capillary, are no more than gelatinous cylinders, not vascular. The cellular tissues, and the fibrous membranes which serve to contain the vascular fasciculi, in the spleen, for example, and in the erectile tissues, are in a similar situation. It is the same with the mucous membranes, kinds of parenchymæ, in which the vessels disappear very abruptly. As for the serous, areolar, and adipose tissues, inflammation proves to us that they are very vascular; but this same remark always holds good, that their vessels, whether sanguineous or lymphatic, are cylinders of simple gelatin. The lymphatic glands appear possessed of very little vascularity, as we may infer from the manner in which inflammation is carried on; we know with what facility their vitality is extinguished, which should induce us to consider them as formed in general, like the tendons, by a mass of gelatin supplied with a small number of lymphatic and sanguineous vessels, and a small quantity of nervous matter.

The calcareous phosphate and the different salts which are combined with the tissues, to give them certain degrees of consistence, elasticity, &c. do not require, in my opinion, the aid of secreting vessels, any more than they do in the zoophytes, and in the mollusca. These salts are collected together by the animal matter itself, which forms them from the blood. I think that it is thus of the other secretions, and that all the vessels not sanguineous, which we observe in the organs that secrete them, are not intrusted with the office of separating from the blood the matter that issues from the glands, but only to gather up the molecules, and to bring them together in a mass, in order to be conducted to their respective destinations.

Thus then it appears to me, that the primitive organic matter, not vascular, is much more abundant in our economy than is commonly believed. I think that to it are intrusted the duties of assimilation, composition, decomposition, secretion, and the formation

of humours, the like of which are not found in the circulating fluids; in a word, of every thing that concerns vital or organic chemistry.* It is my opinion, that the vessels, of whatever class they may be, are not the agents of these phenomena; that they co-operate only in conveying to the matter not vascular the fluids which it requires, and in bringing back these fluids, their residue, or those of new formation, either into the current of the circulation, or into certain receptacles, where they are to serve for the accomplishment of some function.

It is also my opinion, that in this animal matter, forming the basis of all the tissues, and which always contains more or less of nervous matter, all pathological phenomena are developed: I think that the vessels and nerves, properly so called, are affected only secondarily, the one for the conveyance of fluids, the others for the transmission of the stimulation to correspondent parts.

In admitting these propositions, it must be perceived that the phenomena of muscular circulation, which take place in matter without vessels, have been confounded with those of vascular circulation; and, in fact, have all been comprised in the history of what is called the *capillary circulation*. This distinction is, however of great importance in estimating the forces which co-operate to the progression of the blood, and we now proceed to endeavour to make it understood.

Once in the capillary system or reticulated structure, the blood is at the disposal of all the tissues; as the anastomoses are numerous, it may be drawn from all sides by the stimulations which are developed in the different portions of the animal matter. But if it is not diverted from its course, it reaches the veins and returns to the heart without undergoing much extravasation; I say *much*, for it always experiences some, since it is necessary that it should serve to the nutrition of parts, and supply certain secretory organs whose action is uninterrupted. Hence, there always takes place more or less of extravasation; but it is not all extravasated. There is no doubt that a great number of venous radicles may be continued from the small arteries, since microscopical observations have demonstrated it. This is what I call the great route or direct course

* The author might have still farther strengthened his position by a reference to vegetable physiology. In plants there is no circulation properly so called—the movements of the fluids are mainly molecular. They have, if we are to credit the ingeniously conducted experiments of Dutrochet, nervous action without continuous nervous cords, and secretion and new growths without distinct vascularity.—Trans.

of the blood. It undoubtedly exists in all the organs, or at least adjoining them; but it must be larger, if I may so express myself, in the lungs, where the black blood is presented only to be submitted to the action of the air; in the liver, where there arrives a much greater quantity than is required for the secretion of the organ, and for its nutrition; in the spleen; in the alimentary canal, which, except during the time of digestion, receives much more than it has any need of for its own maintenance. There are also tissues in which this route is considerable, such as the muscles, which receive a great quantity of it, to supply the contractions that may be required, and which may also remain a long time inactive.

But, on the other hand, there are many of the tissues where the sanguineous capillaries are few in number, because the functions allotted to their organs do not require so great an expenditure of blood as the preceding. Of this number are the tendons, ligaments and bones; tissues which, forming a great part of the mass of the individual, co-operate, but in a passive manner, to the exercise of functions. They have a *vis inertia*, which depends on their composition, and this latter is the effect of nutrition. As it is for nutrition that the blood is conveyed to them, they receive but a small quantity of it, and almost all that reaches them is extravasated in the animal matter of which they are formed. I should even be induced to believe, that the whole of this fluid there undergoes extravasation, and that consequently the great or direct course is not found in them, but exists in the adjoining parts.

It should be the same case with the sclerotica and the membranes which secrete the humours of the eye: the chief course of the blood cannot be in them; but this fluid can be diverted from them by the vessels which form the ciliary processes, and by those of the choroid coat, and of the conjunctiva.

If the brain receives a great quantity of blood, it passes principally into its pia mater and gray substance, and it is there that the direct route must be found by which, through the veins, this fluid is deposited in the sinuses; the white pulp receives only a very small quantity, and we cannot admit there the direct termination of the arteries into the veins; but vessels pass through it to convey the blood to the central grayish matter in the corpora striata, and in the interior of the medulla oblongata, &c.

The serous membranes, the fatty and areolar tissues, being intrusted with a secretion, or, as it is commonly called, an exhalation, undoubtedly receive a great quantity of blood; but except when they are in a phlogosed state, we can discover in them no redness;

it is therefore presumable, that the arteries have not there a direct junction with the veins.

The mucous membranes vary much in respect to their colour, and their secretions; so that it is difficult to determine if the sanguineous current traverses them without interruption. I cannot believe that it does; but they have behind them numerous capillaries, into which the blood could easily be diverted, particularly in the lungs, the digestive canal, and the genital organs.

We proceed now to view all these tissues in action, in order to observe their relations to the circulation, as considered in the capillary system.

We will commence by observing, that all these tissues never evince, simultaneously, the highest degree of action. Let us suppose the circulation to be excited by the muscular system: a great number of locomotive muscles are contracted; they invite the blood in abundance into their fibrin, perhaps a hundred times more than is required for their nutrition; whence it would result, if this is the fact, as I believe it to be, that the blood, extravasated into their fibrin, assists their contraction, and will be diverted from the direct route much more when the muscles are in activity than when they are in a state of repose. The same extravasation that assists their contraction, increases their nutrition, since they acquire greater size,—as ought to be the case. The muscles, after having made use of the blood for their contraction, throw it into the venous system; and this cause, added to the stimulation which they transmit to the brain, and to the heart, by means of the nerves, imparts to this fluid a motion much more rapid than that to which it was subjected the moment before.

Let us contrast this acceleration of the course of the blood, with that which is produced by the influence of an organ in that pathological state called *fever*. In this case the stimulation produced in the inflamed point commences by inviting the blood towards it, and hastening the movement of its molecules without the heart's participation; but like the muscles, in contracting, it returns to it more blood than it received before; then it acquires force; it is reflected to the brain and the heart: this latter hastens its contractions, and the blood is poured in abundance into all the capillary tissue. Well, in this case the muscles do not act; more frequently the blood, which abounds in their tissues, follows the direct route with so little extravasation, that the nutrition of the organs is prodigiously diminished.

During these two kinds of accelerations, the blood is differently affected in the capillary system of the other tissues, according to the degree of action which will be imparted by the causes peculiar to them. Thus, in the capillaries of the pulmonary vein and artery, where the great route is extensive, this fluid will always abound whatever may be the cause that hurries the action of the heart; whilst there scarcely arrives more than usual in the serous tissue of the lungs. The same difference will be observed in the abdomen; the blood will flow in abundance into the vessels called *mesenteric*, without any inceease of colour in the peritoneum and the tissue contained in its different folds. With regard to the mucous membrane, it will be very differently affected according to the nature of the case: in the acceleration of the blood by exercise, it will not be more injected; in fever, it will always be more so, and its secretion will be much increased, not because more blood arrives in the capillaries which are situated behind it, but because it will participate in the irritation of the point inflamed, if it be not itself primarily inflamed, that is to say, the principal cause of the febrile state. It is then evident, that in the first case it will not divert the blood from the great route of the mesenteric capillaries, whilst in the second, this deviation will be very considerable.

The same observation may be made with regard to the liver: in the acceleration of its blood, occasioned by exercise, this fluid will traverse, without remarkable deviation, the great capillary route of this organ; whilst, in the acceleration caused by gastro-enteritis, the secreting vessels of the liver, excited by this phlegmasia, will divert a great quantity of blood from the direct course, and fill with bile the digestive canal, already stuffed with mucosities produced by mucous inflammation.

If we cast a glance over the skin, we shall observe in it differences no less remarkable in the two kinds of acceleration that we are now contrasting with each other. We will first observe that the skin has no resemblance to the greater number of internal exhalent surfaces: these latter, except, however, the mucous membrane lining the lungs, are not increased in action by the influence of the blood alone which reaches them; a peculiar stimulation is always necessary to dispose them to receive this fluid in a greater quantity than usual. The skin, on the contrary, is, in its normal condition, the natural resort of the blood accumulated in the interior; it receives it by a kind of reflux; it becomes the diverticulum of the viscera, and the pores with which it is filled, while allowing much

of the serosity to escape, free the body of the fluids that the acceleration of the blood would otherwise render superabundant in the economy. Hence as long as the individual enjoys good health, exercise produces, with the colouring of the skin, a considerable evacuation of sweat. The same thing happens in fever, where the skin is not diseased; this is confirmed in acute and chronic peripneumonias: but if the cause of the fever is of such a nature as to transmit a constrictive irritation to the skin, the blood will be presented in vain to its tissue; it will not expand; and although the skin may be burning, it will also be dry, hard, discoloured, pale, or overspread with livid spots; in a word, it will exert no derivation from the capillaries which place the blood at the disposal of its excretory vessels.

There are certainly very considerable differences in the quantity of blood which traverses the parts where the irritation predominates, and where the sanguineous capillaries abound; they are still greater, if we compare these tissues with those in an opposite temperament, which have no sympathies, and where we have said that the capillary system was not enough developed.

For example, in vain would any cause, whatever it might be, accelerate the course of the blood; the tendons, aponeuroses, and bones, would never receive a greater quantity than usual. If it were otherwise, we would see them swell and soften in fevers with plethora; become thin and be dissolved in febrile atrophies, as takes place in the muscles and the parenchymæ of the viscera, and the foundations of the animal edifice would be destroyed. But this never happens; these tissues are inert and entirely passive in the greatest exaltations of the circulatory function. The blood, urged on by the heart, is presented to them in vain; they repel it, or receive only the quantity necessary to their nutrition; the blood flows into the medullary membrane, the periosteum, &c.

But, without stopping to consider the tissues whose inertness is so striking, it is sufficient to examine the humours of the eye in the accelerated course of their generating blood. Has any one ever seen the turgescence of the capillary system surrounding them, communicated to their membranes, and cause them to lose in an instant their transparency? This could only happen whenever inflammation is developed in them; but then their animal matter would have changed its condition, the stimulation would have rendered them more porous, extravasation would become more considerable; perhaps even sanguineous vessels would be developed

there, as is seen to take place in such cases in the serous membranes of the principal viscera; and the direct communication of the arteries with the veins would be then established.

It is urged, in favour of this general communication, that the tenuity of the vessels is such in the white tissues, and the tendons, that the red globules are there decomposed, which renders the passage of the blood imperceptible. Now, this opinion coincides perfectly with our own; for this extreme tenuity of vessels is equivalent in our minds to their disappearance, and the passage of the molecules of the blood through the interstices of the animal matter, which has ceased to be organized, in the form of vascular walls. But observe, that the opinion which I combat is founded upon an hypothesis; for who has seen these vessels? Inflammation, it will be said, renders them perceptible. To this I will reply, that it creates them, as in adhesive exudations, and gives to the animal matter a new disposition, by rolling it in small cylinders, and by preparing it for the reception of the stream of the blood. But inflammation abating, these cylinders disappear, the organic matter resumes its former arrangement, and no longer admits the blood in streams, but only in molecules which roll slowly between its own. Besides, I repeat it, when we have imagined the smallest vessels possible, it is absolutely necessary still to admit that the fluids which nourish their walls should pass between their molecules without being contained in these vessels.

When the fluids, red or white, circulate in streams, I say that there are vessels; but I can no longer perceive them whenever these streams cannot be demonstrated by any optical instrument; otherwise I do not see why it should not be maintained that the animal matter which forms the circulatory vortices, is nothing but vessels. And what would be the limit of this extraordinary multiplication! The hardest mineral substances have interstices between their molecules; wherefore then deny that animal matter should possess them? It has them in fact; and if it possesses them, they ought to be traversed by the fluids when these latter have arrived at the termination of the small vascular branches. It is there, and not in the vessels, that all the transformations of animal matter ought to take place; they are produced with rapidity or slowness, according to the vitality of the tissues, which determines the duration of the passage of the fluids. This vitality is not then submitted to the impulse of the heart, nor even to that of the coats of the capillary vessels; the latter on the contrary are governed by it, and if the capillaries are

seen to be rapidly agitated in an inflamed tissue, it is because the movements of transformation, whether nutritive or secretory, are primarily accelerated in the animal matter to which they present the blood; for they are subject to its sway, whilst it is rarely if ever at their disposal, as we have already more than sufficiently proved, when studying the deviations of the blood in the febrile state, and in the acceleration produced by muscular action.

Whether this acceleration arises from the repeated contraction of the muscles, or results from a point of inflammation, or simply from the exaltation of some function, as in digestion, or in the excitement of a moral affection, invariably is it the case that it has its first cause in an irritation which does not originate in the vessels, but rather in the molecules of the animal matter. It is this matter which, agitated, disturbs the regularity of the course of the blood in its capillaries. The irritation of this matter, transmitted to the encephalon by its conductors, the nerves, is reflected to the other organs, and developes there the phenomena of the part from which it originated.

It is thus that we explain the capillary circulation. Let us now recapitulate.

Section IX.—*A Summary View of the Phenomena of the Capillary Circulation.*

The blood, having reached the capillary reticulated structure, does not await there, in a state of stagnation, the demands of the different tissues, in order to flow in greater or less quantity to one or the other; it continues to circulate, propelled on by that which comes from the heart, and the greater part of its molecules reach the venous apparatus, because there is always, in certain places which we have pointed out, a direct communication of the small arteries with the small veins; in other words, because these sets of vessels dip equally into the capillary net-work.

The small cylinders which form this net-work are immersed in the midst of animal matter not vascular; they are themselves formed of it; they are to pour out in the interstices of its molecules the fluids necessary to its nutrition, and functions; they always furnish it; they receive continually the effete portion, which changes the quality of the circulating blood, while accelerating greatly its progress towards the veins.

When any portion of this animal matter enjoys an unusual de-

gree of action, the capillaries are compelled to furnish more blood to it; the extravasation becomes more considerable; the blood is more altered, as is proved by its colour being always blacker in the seats of inflammation than in healthy parts. At this time the regularity of the course of the blood is more or less disturbed : its movement is always greatly accelerated, and this may be carried to such a pitch, that this fluid traverses with great rapidity the capillaries adjoining the inflamed part, in an entirely opposite direction to that of the natural state.

Certain tissues, much less active than others, receive, appropriate, invite, and divert, in short, only a very small quantity of the blood contained in the capillary net-work; hence the latter is always less considerable in these tissues than in others.

When the course of the blood is greatly accelerated, that part of it which is directed to the inert tissues is diverted and drawn towards the capillaries of parts naturally more active; and as it exists in all parts which expend little of the fluids, so there is always found within the reach of these latter, capillary net-works of derivation which prevent the blood from remaining in the vicinity of the inert tissues. It is thus that this fluid proceeding towards the serous is diverted by the capillaries of the mucous tissues, or of the secreting organs; that which ought to go to the bones, by the capillaries of the cellular tissue, and marrow; that which is directed towards the tendons, aponeuroses, and ligaments, by the muscles; that which proceeds towards the white pulp of the brain, by the capillaries of the cineritious portion; and that which would be too abundant for this last, by the sanguineous net-works of the first, &c.

In numerous cases, the partial irritations generated in the molecules of the animal matter are too inconsiderable to react upon the nervous apparatus to the extent of agitating the heart; then the derangements of the capillary circulation take place only in the neighbourhood of the diseased part, and form around it a kind of inflammatory atmosphere. The action of the vessels of the part increases, not in frequency, since that depends on the heart, but in force; the extravasation is more considerable, and all the local changes are perverted.

The explanations which I have just given, appear to me adapted to reconcile the opinions of those physiologists who maintain that the blood may be thrown by the heart even into the veins, with the belief of those who affirm that the capillaries alone exert an influence over its progression. I believe what I have advanced to be

founded on facts, and I confidently expect that experiments will soon come to the support of this theory.

Section X.—*Summary Description of the Venous Apparatus in general, and of its Divisions.*

The veins are cylindrical tubes, destined to bring back to the heart, with all the fluids that have been absorbed, the blood which that viscus had sent out into all parts of the body, by means of the arteries. They are usually divided into two systems: the one general, which terminates directly in the heart; the other peculiar to the abdomen, and which terminates in the first system. It appears to me that it is more natural to divide the venous apparatus into three trees, which are essentially very different from each other. The first is the pulmonary one, the branches of which are ramified through the lungs, and the trunk implanted in the left auricle of the heart; the second is the general tree or great venous apparatus. We distinguish in the latter the two trunks terminating in the right auricle; from those two, the superior trunk has its branches, and ramifications in the head, face, neck, and the upper or thoracic members; whilst the inferior, much more expanded, has its branches in all parts of the body. The third venous tree is only an appendage of the second; it consists of the vena portæ, and is composed of a very short trunk which has its roots in the digestive organs, and its branches in the tissue of the liver.

Section XI.—*Of the general Structure of the Veins.*

The walls of the veins are much thinner than those of the arteries; they are of a grayish hue. We discover three membranes in their composition: 1. The external, which is cellular, and compact, and formed of an infinity of interlaced filaments, which dip between the fibres of the second: 2. This latter, which is the middle, and called *proper membrane*, is fibrous, lax, extensible, and very contractile. It is composed of longitudinal and parallel fibres, more evident in the divisions of the vena cava superior than in those of the inferior, in the superficial veins than in the deep-seated; but the readiness with which these veins contract, proves that they have also circular fibres. Bichat and some other anatomists do not consider this coat as muscular, by which is meant that it is not formed of fibrin: it is in fact gelatinous; is gelatin in a particular condition,

adapted to the functions of this class of vessels. In the cerebral sinuses which perform the offices of veins, the dura mater supplies the place of the two coats of which we have just spoken. 3. The third, or internal coat, is called *internal membrane;* it is smooth, and polished, nearly resembling that of the arteries, but more delicate, and forming by its folds the *valves.* These are of a parabolical form: their free edge is turned towards the heart; the adherent one is convex; they are formed of two laminæ very difficult to separate, in which are frequently distinguished white fibres crossing each other; they do not exist in the pulmonary veins, in the vena cava superior, in the inferior as far as the iliac veins, the internal jugular, the sinuses of the brain, and the vena portæ. They are generally found in all other parts; but they vary in number and situation.

The coats of the veins of a certain size contain small arteries, veins, and absorbents; the internal has exhalent porosities, since it is always lubricated with a dewy lymph. According to some authors, nervous filaments from the ganglions are found in the veins; but others deny their existence. Besides, they must be very few in number; for the sensibility and the sympathetic relations of these vessels are very trifling.

The venous trees of the lungs and digestive viscera have but one arrangement, which reigns throughout their entire tissue; they accompany with sufficient regularity the arteries of those parts, and exceed them in bulk. We have already seen that they are destitute of valves. The great or general venous tree has two subdivisions, the one of which, or the deep-seated, accompanies the arteries, and is always of a more considerable diameter: and without valves. The other portion of this tree is superficial, sub-cutaneous, and unaccompanied with arteries. In the cephalic cavity, the small veins of the dura mater empty their blood into the sinuses which furrow the internal face of the bones of the cranium, and which are formed by the folds of the dura mater. These sinuses possess no contractility, nor do they contain a valve which could present an obstacle to the progress of the blood. The superficial division of the general venous tree forms frequently a very considerable and irregular net-work, in the sub-cutaneous cellular tissue; there are many valves found in it, and its extensibility is very great.

The venous tree of the abdomen merits particular attention; it arises from all the veins of the viscera of this cavity, except the

kidneys and their appendages, and, in the female, the uterus. All these veins join together to form two principal ones, the inferior mesenteric, and the splenic, that unite in their turn to form the vena portæ, the diameter of which is less than that of the two veins by which it is formed.

The vena portæ, about four inches in length, extends from the vertebral column to the transverse sinus of the liver; it is situated under the small extremity of the pancreas, behind the duodenum, and covered afterwards by the hepatic artery and the communis choledochus and hepatic ducts. Arriving at the concave surface of the liver, between two protuberances that are called *portal eminences,* it is divided into two branches, which separate at a right angle, to the right and left, forming the *sinus* of the vena portæ. These two branches accompany the hepatic artery in all its divisions; they ramify in the tissue of the liver, and are always enveloped by a prolongation of the fibrous membrane of this viscus, which is known under the name of the *capsule of Glisson.* The vena portæ may then be represented as a tree having a very short trunk, and branches which end in the two capillary systems, located, the one in the digestive organs, and the other in the liver. This is the only example of the kind to be found in the body, since all the other veins have but one capillary system at the extremity, their trunk being always implanted in one or other of the auricles.

Section XII.—*Of the Functions of the different Venous Apparatus, or of the Venous Circulation.*

It is from the general capillary system that the last subdivisions of the venous tree, or the venous radicles, draw up the blood. This fluid immediately ascends in their branches in order to arrive at their trunks, which empty it into the auricular cavities of the heart. This is the general fact; but there are other particular ones in connexion with this first, which serve to explain it. These we now proceed to set forth. The veins are not inert tubes; they are endowed with a contractility, in virtue of which they exert a continual pressure on the contained fluid. This pressure ought necessarily to produce its displacement; but does it force it to advance towards the heart, notwithstanding the diminution of the space that it traverses, in passing from the ramifications into the branches, and from the branches into the trunks? or rather is this pressure confined to acting in a general manner upon the fluids, whilst the

centripetal progression would be exclusively .produced by the molecules which reach the veins, as propelled by the impulse of the heart, and by that of the capillary tissues? In other words, is the contraction of the venous walls directed from their extremities towards their trunks, or is it only perpendicular? If we reflect upon the action of the lymphatic vessels, we shall be inclined in favour of the first mode of action, for it is impossible to imagine a *vis à tergo* in the absorbing mouths. There is in this case no impulse of the heart to determine the chyle and the lymph into these mouths, whatever they may be; it is requisite than that they should be endowed with a pumping and an absorbing power, and that a contractile movement, directed from the extremities and branches towards the trunks, should alone effect the progression.

Now, if this property is granted to the extremities, and to the coats of the lymphatic vessels, I do not see for what reason it will be denied to the veins, particularly since they are seen to take up blood which has been extravasated in the parenchyma of the organs, or upon some surface. Such is that which the umbilical vein absorbs in the capillary tissues of the internal surface of the uterus, in order to conduct it to the embryo.

I think, therefore, that the veins are endowed with contractile movements, acting from the circumference of the body towards the centre, and I believe that this action is one of the principal forces which causes the return of the blood to the heart. These movements cannot be continued; they ought then to alternate with a state of relaxation; and we may, without fear of error, imagine them altogether similar to those of the heart. But they are so slight, that as yet they have not been rendered by any process perceptible in the majority of the veins; they are, however, very visible in the vena cava of frogs, at the point where it joins the auricle. In the experiments that doctor Sarlandière made upon the circulation, we observe these movements to be independent of the heart, since, after having removed this organ, we saw the contraction and relaxation of that vein continue during many minutes in the cut extremity, and persist even after the fluid had ceased to arrive.

Many physiologists have likewise observed this contraction in the vivisections of large animals; they have attributed it to the muscular fibres which they discover round the trunk of the vena cava. These fibres ought undoubtedly to produce it; but it can take place without their assistance, and in gelatin alone, as we have ascertained to be the case in the frog. Now, I believe that these

contractions are common in the whole extent of the venous coats, although they may be only distinctly appreciable in the trunk of the large veins.

Next to the contraction of the coats of the veins, it is necessary to admit, as auxiliary causes of the centripetal movement, the impulse of the heart and the action of the capillary tissues. And, indeed, these powers contribute to this effect in a very efficient manner, by acting as a *vis à tergo*, and because, moreover, irritation of the capillaries is propagated immediately into the venous radicles.

It is here necessary to recal to mind the distinction of the two routes that we have admitted in the sanguineous circulation. The blood of the veins which correspond to the arteries in that which we have named *the great route*, ought to be more acutely sensible to the impulse of the heart; hence the aid of valves is in them less necessary. This is observed in the veins of the lungs, in those of the abdomen, and in the jugulars, where, besides, the progression of the blood is facilitated, throughout a great part of the diurnal circle, by the perpendicular direction. It is not thus with regard to the veins of the limbs; we have seen that the quantity of blood which traverses them was susceptible of numerous variations, according as the muscles were more or less exercised. The impulse of the heart is much weaker in them than in the veins of the viscera; hence they are provided with valves very near to each other.

The most powerful *vis à tergo* is produced on them by muscular action; and when this latter becomes feeble, the blood always undergoes a considerable diminution which soon brings on atrophy.

With respect to tissues where the direct communication of the arteries with the veins does not exist, where the blood is necessarily extravasated, and the impulse of the heart almost nothing in all their veins, the molecules simply propel each other, but with a slowness proportionate to that of nutrition: besides no sympathetic irritation happens which can accelerate the movement; it is but inflammation which renders them sometimes more rapid, by expanding these tissues, and imparting to them, for a longer or shorter period, a more vascular organization, one approaching nearer to that of the other parts of the body.

It is now time to treat of the venous circulation of the abdomen. A great number of arteries pour out the blood into the intestines and spleen. This fluid passes immediately into the radicles of the vena portæ; and as it is little removed from the heart, it

doubtless still preserves much of the impulse which it received from that organ. We must nevertheless necessarily admit that it receives a very considerable impulse from the stimulation imparted to those viscera during digestion. Be this as it may, the blood of the vena portæ, instead of arriving directly in the vena cava, is poured into the liver, and traverses anew a capillary apparatus, before reaching the heart. This singular arrangement has caused the belief that the blood of the vena portæ was destined to afford the materials for the secretion of the liver. We shall consider this question when speaking of the functions of that viscus. The subject now before us is simply the circulation of the blood: and it appears to us that it may be considered in the venous system of the abdomen, independently of every secretion. If, indeed, I examine the liver and the spleen in reference to the circulation, I find in them many very remarkable peculiarities.

In the fœtus, in which there is scarcely any biliary secretion, the liver receives by the umbilical vein an enormous quantity of blood, so great that the bulk of viscus is proportionably more considerable than in the adult. Now, since this fluid is not destined to the formation of bile, it must have another use. For myself, I am of opinion that the liver serves at that time as a reservoir for the blood; that this fluid is deposited in it, to be within reach of the heart, in order that this organ may never fail of its supply, and that it may always find the fluid there in a state fit for the performance of the functions. And, indeed, if the current of the blood which arrived at the heart was confined to a simple vein, I do not think that there would be a sufficient quantity to insure the continuance and regularity of its pulsations.

If, on the other hand, the action of the heart became weakened, so as not to take up the whole of the blood which might be placed within its reach, this fluid would remain stagnant: but if it stagnated in a simple vein, the vessels would be liable to enormous dilatations; the blood would coagulate there; the vein which should contain it would lose its elasticity, perhaps even be ruptured. There was then required near the heart not a vessel, but a reservoir of blood. But suppose that nature had placed there a large sac similar to the stomach, for example, then the inconveniences of coagulation would still have presented itself. It was, therefore, necessary that the reservoir of blood destined for the heart should be a capillary apparatus, in which the fluid could be accumulated without danger of excessive dilatation, followed by loss of tone, rupture, or coagu-

lation. Now, the liver fulfils this office for the right, as the lungs for the left side of the heart. Let us compare next the fœtus with the adult, agreeably to this interesting view of the subject.

In the fœtus, the superabundance of the blood afforded to the right auricle, is kept in deposit in the capillary tissue of the liver; in the adult, the same phenomenon occurs, with this difference only, that the vena portæ takes the place of the umbilical vein, supplies the same capillaries that this vein supplied, and prevents, like it, every irregularity of the action in the heart. Finally, in all ages of life, the lungs perform the same office in relation to the left cavities of the heart.

The liver and the lungs have then a double office; the one relative to their particular functions as organs of secretion and absorption, the other which is common to both, and exclusively in the province of the circulatory function. With regard to the spleen, I confess that, so far, I can imagine no other use for it but that of being auxiliary to the circulatory function of the liver, since it is confined to diverting a part of the blood of the abdominal aorta, in order to pour it immediately into the liver, and in this manner to co-operate in the supply of the reservoir or the right cavities of the heart. In other words, the spleen is nothing else than a small or secondary reservoir, or auxiliary of the great one which is situated in the liver.

Let us inquire now into the office of these two reservoirs or diverticula, in cases of very great acceleration of the course of the blood. Every time locomotion is hurried, the muscles throw a greater quantity of blood than usual into the veins. The heart is therefore compelled to increase its pulsations; it forces the blood in a large quantity into the viscera: that which issues from its right ventricle is accumulated in the capillaries of the lungs; it compresses and diminishes the bronchial vesicles, and affords an abundant pulmonary exhalation: that which is driven from its left ventricle takes different directions, according to the arteries that it traverses. The blood which is too abundant in the head and muscular apparatus flows back into the superficial veins, and into the skin, which last becomes swoln, expanded, and covered with sweat. This does not happen with that which is superabundant in the abdomen: not being able to proceed to the skin nor penetrate into the secreting vessels of the abdomen, which reject it, unless they are already over-excited, this fluid finds a retreat only in the ramifications of the vena portæ, in the spleen and liver, the numerous capillaries of

which serve, without any inconvenience, as a place of deposit, until the heart shall be able to give it a passage, and re-establish the equilibrium. If it were otherwise, and that the secreting vessels of the abdomen were as easily opened as those of the skin and lungs, it is evident that all violent exercises would produce hæmorrhagies by the mouth and anus, or rather vomitings and diarrhœa.*

We now propose offering a summary of the phenomena of the circulatory function.

Section XIII.—*A Summary of the Phenomena of the Circulation.*

The heart is stimulated by the blood brought to it: the veins present this fluid to the two auricles at the moment in which these latter are at rest; and these by their contraction drive it into the ventricles, which are at rest when the auricles are in action. The ventricles have no sooner received the blood than they contract and throw it into the arteries; these vessels react on the contained fluid, by a movement of elastic contraction; and as the portion coming from the heart prevents its retrograding, the arteries convey it to their extremities, which pour it into the capillary system. Having arrived in this system, the blood follows different directions; a part is directly transmitted to the veins, without having undergone any extravasation, and returns promptly to the heart; another is diverted from the vascular current by the secreting organs, and which varies greatly in quantity, since some of them, such as those of the skin, are obliged by the mere afflux of the blood to deprive it of a large portion of its elements, whereas others only receive and divert it from the vascular current, in proportion to the degree of action with which they are endowed, independent of the heart; another portion of the blood serves for the performance of muscular movements, and of the internal and external sensitive functions; whilst, finally, another is destined for nutrition. It follows from this, that the blood, once out of the large arteries, may traverse the capillary

* What has been just said on the functions of the liver and of the spleen, is but the summary of what I published in the 8th volume of the *Memoires de la Societé Médidicale d'Emulation,* I have sought only to simplify and perfect this theory, which for the last nine years I have advanced in my course of physiology. An essay inserted in the Journal Général de Médecine, appeared to me to render this short note necessary.

system, and the interstices of fixed animal matter, in every direction, and even go through the small vessels in a very short time in entirely opposite directions. In the round of the circulation, the blood is enriched by different principles furnished to it by the air, aliments, and by the fluids deposited on the surfaces, large and small, which it traverses. Absorbed by the veins, the blood returns to the heart by the triple impulse of the contractile power of its containing vessels, of the particles which are constantly sent forwards by the arterial extremities, and, finally, by the capillaries and fibres of every description.

The greater number of the veins convey it directly to the heart while making it traverse a space continually decreasing, by which means the fluid is more and more compressed; other veins, after having brought all their contents into a single column in their central trunk, diffuse it anew into the capillary apparatus of the liver, in which it forms, together with the blood proper to this viscus, a reservoir, the office of which is to furnish blood to the heart, and to serve in certain cases as a safe retreat for this fluid.

The heart is placed between two very powerful forces, between which it must preserve an equipoise during the entire period of existence: 1. The impulse of the double current of venous blood which advances to it, and tends to keep its two auricles in a state of continual dilation; 2. The resistance of two columns of arterial blood, which tends incessantly to restrict the contractile movement of its two ventricles, or its systole. The heart is associated with all the tissues by the most active sympathies: as the irritations of all points of fixed animal matter may hasten the return of blood towards this viscus, it must always be ready to accelerate its contractions, in order to afford a passage to this excess of fluid. Hence a great number of variations in its movements, which all take place through the medium of the nervous system; and hence the heart is furnished with nerves of every description (S).

Of the Alterations of the Circulatory Function, which may become causes of Disease.

These alterations must be examined in the heart, in the arteries, in the capillary system, and in the veins.

Section XIV.—*Of the Alterations of the Heart.*

The cause of the changes in the state of the heart must be sought for in the influences which may derange, that is in those which support, its action.

The heart receives its share of the stimulation acting on the animal economy, by means of the nerves, which it possesses in common with all the other organs. We find it accelerating its contractions, under the influence of the intellectual operations and the passions; and so soon as an irritation of any moment is developed in a tissue, the heart always participates in it by an increase of its palpitations. Let us examine separately the influences which it receives from each apparatus.

We have elsewhere said, that whenever the encephalon was strongly stimulated by the exercise of thought, the irritation of this organ was diffused, by means of the nerves emanating from it, through all parts of the body; but that it only produced well-marked effects in the more mobile tissues, the first which are destined to be in action in the various relations. Now these tissues are the viscera, their annexed secretory and excretory organs, and finally the skin: the remainder of the body seems to me susceptible only of being affected in a consecutive manner, either by the disorder of the circulation or by the spread of the irritation at first developed in the most nervous and sanguineous tissues.

But of all the parts which more immediately receive cerebral emanations, none is affected in a more lively manner than the muscular tissue of the heart. We have elsewhere treated of the disorders occasioned in the lungs and digestive apparatus by this irritation; let us now examine the ones peculiar to the heart, which, however, is always affected simultaneously with those viscera.

Pleasure in general, and more particularly that very distinct modification of it called *joy*,—pain in all its varieties, whether physical, as that resulting from external violence, or irritation inflammatory or not, or moral, as in fear, shame, anger, &c. cause the heart to palpitate with violence. In this irritation the organ does not always propel the blood with a celerity proportioned to the stimulation it receives; which shows that the force of the pulse, and the heat and redness of the skin, do not invariably correspond with the heart's action, though it be observed on many occasions. In all other cases the heart seems to undergo a kind of constriction, which

narrows the arterial orifices, so that the blood, in place of circulating more freely, is retained in this organ, and in the lungs and brain, and is not sufficiently oxygenated to meet the wants of their respective functions. I say their functions, for the tissue of the heart requires that vessels should convey red blood to it as well as to the brain; and the pulmonary sense cannot fail to suffer, when it does not meet with enough of oxygen in the atmosphere. Hence results a feeling of suffocation, a momentary suspension of the respiratory act in the lungs, and impending syncope in the brain. These phenomena are sometimes carried to such a pitch, that if a person walk he is obliged to stop short; and he feels at the same time a pain in the heart, more or less extended to the chest and epigastrium, and to the arm of the same side: from this group of symptoms has been formed a general or idiopathic disease, called *angina pectoris*. More frequently it does not take place unless the heart have been organically altered; but it may be observed when the organ is healthy, owing to the causes already pointed out.

Here then we have two kinds of palpitations from a moral cause, for pain from a physical agent is a moral affection; one kind in which the circulation is really accelerated, the other in which the course of the blood seems rather to be retarded. When these two kinds are kept up for a length of time, they finally fix the irritation in the tissue of the heart, and give rise to disorders, a picture of which I shall present, after I shall have pointed out the other influences that may impair the action of the heart, and which, from being natural as they were, pass into a pathological state.

Irritation of the organs may, without being distinctly and acutely felt by the centre of perception, so act upon the heart as to occasion a great increase of its movements, as happens in all phlegmasiæ of a certain degree of intensity. The course of the blood is on such occasions always greatly accelerated; to which general heat and the increased redness of the parts are joined, constituting the principal phenomena of the state called *fever*. The kind of acceleration of the heart's pulsations which produces it has not received the name of *palpitation*, though it has the closest analogy to this latter state. In fact what can more nearly resemble fever than those violent and durable agitations of the heart, the effect of anger, wounded self-love, &c. in which we observe, during several hours, a full pulse, burning skin, sparkling eyes, and red face? Has not the appetite likewise disappeared, and is not thirst associated with this state?

Does not the person experience also a feeling of distress, and even of severe headach? So great is the resemblance, that very often at the expiration of a certain time we discover that the person thus affected is sick, and we give the name of fever to the disordered circulation under which he suffers. The heart is not at this time the only part irritated; the other viscera, and especially the stomach, evidently sympathize with it, as happens in that kind of acceleration, the product of inflammation, to which we affix the epithet of *fever*. Whenever there is fever then, the circulation is greatly deranged; the blood arrives in all the tissues in greater abundance, and the viscera among other parts receive from it a peculiar irritation, for the blood is a natural incitant to the entire organization.

As irritation of the heart is the fundamental phenomenon of fever, no person can be surprised that this viscus retains and appropriates to itself the irritation, which it first experienced only sympathetically; and that, consequently, it becomes diseased in those who often suffer from inflammations, carried to the extent of causing fever.

Thus we find that irritation, under the form of pleasure, or of physical or moral pain, and inflammation even without pain, often act on the heart with such intensity, as to alter its normal state, by becoming fixed in its tissue. We hence learn why diseases of the heart succeed various phlegmasiæ, whether acute or chronic.

Certain tissues of a structure analogous to that of the heart, such as the locomotive muscles, would seem to transmit with more readiness than other parts, inflammation to this viscus, after having at first irritated it by sympathy; hence we often see it becoming diseased after muscular rheumatisms. Those of the articulations seem to produce the same effect. It remains for us to ascertain whether these rheumatisms do not act in preference on the tendinous tissues of the heart, which, like the ligaments, belong to the fibrous system; and whether the irritation of the synovial capsules has not a tendency to be repeated in its internal or external membranes, which constitute a part of the serous tissues. I do not after all believe very implicitly in the constancy of the transfer of irritation to analogous tissues: it is very evident in some cases, as for example, in irregular gout; but in many others in which it does not take place, the irritation may traverse the body in all directions, and stop in organs of a totally different texture from that of the tissues in which it originated. It is thus that the heart, of which we are now treating,

receives its irritation from all the organs, and may retain and appropriate it to itself, no matter from what part it was transmitted.

Among the different organs the action of which stimulates the heart, are the locomotive muscles, which are the means of associating with the sympathetic influence of the nerves another not less powerful—that of the blood, to which this viscus is very sensible. I pointed out the fact, that whenever a muscle enters into action, it attracts more blood than usual, and hurries it into the venous system. Let us now suppose a great number of these muscles acting simultaneously, and with great energy, as in walking, running, leaping: the heart will be in consequence doubly stimulated; first by the arrival of a greater quantity of blood, and then by the sympathetic transmission of the muscular irritation through the medium of the brain; and if this double stimulation continues, the circulation will be greatly disordered. But we anticipate, as the question at present is of those derangements peculiar to the heart. Experience proves then that the kind of palpitation to which this organ is subject, is one of the most powerful causes of its diseases, and that all these depend on irritation retained by it after excesses of the nature just mentioned. None other indeed give it such terrible shocks; it is felt striking against the sides with extreme violence; the pulse is full, frequent, and hard, and the blood is propelled into all parts of the body with extraordinary impetuosity.

The disorders experienced by the heart during the too precipitate and violent action of the muscles, are still more readily produced, if the exercise be taken in an ascending direction; for in this case we are obliged to make the chest the point of support for all the locomotive muscles. To accomplish this, we suspend respiration, and only allow of the dilatation of the chest when the want of air is very strongly felt. The lungs are therefore of necessity engorged, and refuse in part passage to the blood sent to them by the right ventricle, whence results a permanent plenitude of the two right cavities of this viscus, which may thus contract a fixed irritation.

When giving the effects of strong passions, we must include the violence which the heart undergoes from the blood; for this fluid is retained in the lungs by a spasm which is opposed to inspiration. This latter process is as it were bound up, and if to this state we add the constriction of the heart, which, in place of expanding to receive the blood, is contracted, and retains it in its auricles, we shall form an idea of the facility with which this organ remains permanently irritated. Tickling carried to excess, always produces

precisely analogous effects, inasmuch as the kind of pain resulting, and the efforts of resistance made, render the chest immoveable, and determine a spasm of the heart.

To all these evident causes of disease, we must add another not less so; I mean external violence, as by blows over the region of the heart, violent jars and falls, permanent pressure, and crushing. The heart is always powerfully irritated by such causes, and very generally retains the effects of them during after-life.

Finally, the sudden action of cold must be placed on the list of the most frequent causes of diseases of the heart. Cold repels the blood from the surface, and, accumulated in consequence in the viscera, this fluid gives rise to a distention in which the heart must necessarily participate.

I do not at present speak of its being under the influence of extreme heat, because this effect is referrible to the stimulation of the nervous system, of which the brain is at once the centre and the point most irritated.

We see now how numerous are the accidental causes of the irritation of the heart; with these we must associate congenital hypertrophy, the existence of which is productive of extreme irritability of this organ; and afterwards examine the alterations in its tissue, and in what manner they act on the circulation.

When the heart is more than ordinarily irritated, we observe derangements in the circulation corresponding with the kind of irritation and the region of the heart occupied by it. If it is the external surface or serous membrane which is irritated, constituting the disease called *pericarditis*, the diastole is incomplete; the heart receives less blood than in its normal or natural state, and consequently this fluid must be stagnated in the viscera. In addition to this, the effort exercised by the venous columns on the two auricles is of a painful nature, as is also the contraction of the four cavities. This pain is keenly felt in the acute state, and from this results a stitch more or less analogous to that of pleurisy.

On this perception follows a feeling of oppression; but this latter depends less on the local pain than on the uneasiness resulting from the difficulty with which the blood traverses the lungs,—a difficulty producing deficient oxygenation, so that the pulmonary sense and the brain undergo a peculiar kind of irritation, by which the entire locomotive apparatus is thrown into pain, and the patient is fearful of suffocation and syncope. This oppression is redoubled on the slightest motion; and the contraction of the inspiratory muscles, re-

strained as they are in their efforts by the pain in the heart, necessarily adds to the oppression. The digestive organs likewise suffer, and soon experience a degree of inflammation which cannot but add to the distress of the patient.

If acute pericarditis continue for some days with the same intensity, death is the necessary consequence of the two causes conjoined; the defective circulation and deficient oxygenation. Where the disease becomes chronic, the pain from inflammation is diminished; but the collection of pus in the pericardium, by preventing the expansion of the heart, is an obstacle to the circulation, and the patient is exposed not only to the oppression caused by defective oxygenation, but also to other accidents which likewise occur in aneurism, and which we shall soon examine, when treating of the mode of disorganization of the heart in that disease.

When irritation occupies the internal surface of the ventricles, the openings into the arteries being more easily contracted in diameter than those which admit the blood into the auricles, this fluid enters with facility into the ventricles, but is discharged with difficulty. Hence result palpitations, during which the heart, extremely large and tumid, strikes with violence against the parietes of the thorax. The extraordinary motion to which it is constantly subjected, invites a greater quantity of blood than usual into its tissue, which swells, and acquires much more strength. This kind of hypertrophy is so far peculiar, that the pulsations of the arteries are weak, and present a contrast with the force of those of the heart. In such cases the patients are perpetually harassed by the difficulty of breathing, and of walking; but they have less oppression than is felt in chronic pericarditis, and do not complain of approaching syncope.

When the irritation of the internal surface of the heart is not predominant at the arterial orifices, the force of the pulsations of the arteries corresponds with that of the heart. The same thing takes place when irritation exists only in the fleshy tissue of this organ. These two states necessarily bring on hypertrophy, with a free course for the blood through the four cavities. The changes thereby induced in the circulation are as follow: the heart contracting with much more frequency and force than in its normal condition, and the blood which traverses it meeting with no obstacle, the viscera are always powerfully stimulated, and the respiration is full and strong, and performed with a kind of hissing noise called *puerile*, like that in children. In these latter the heart is, in fact,

proportionally more energetic in its functions than in adults—a condition seemingly necessary for the growth of the former;* but this force diminishes with advancing age, as we find that the activity of the organ goes on continually decreasing from the first day succeeding conception until death, except in cases of rapid growth, and acute inflammation. When, therefore, there is a deviation from this rule in an adult, and when his heart seems to be large and vigorous, and contracts with more than ordinary frequency, without receiving stimulation from any inflamed part, we are justified in considering this viscus as in a state of over-irritation, which frequently produces a true hypertrophy.

With a full, frequent, and hissing respiration, in persons labouring under hypertrophy, without organic obstruction, are always associated a great heat in every part of the body, especially observable at the extremities, which with difficulty become cold; and also considerable energy of the brain and muscular apparatus, a ready assimilation, and usually a small proportion of adipose matter: such persons would seem to live more than others. It is to be observed, however, that they do not bear well stimulants of any kind; indeed an irritating diet harasses them, and gives rise to gastritis, of which they always have a slight degree; heat overpowers, whilst cold weather gives them new vigour: they have at first great readiness for exercise, but after a certain period they cannot tolerate it without experiencing dyspnœa and prickings of the skin, as if thousands of needles were penetrating it. Many persons in this situation have a great propensity to sexual indulgences, and can enjoy them without much exhaustion. I am disposed to refer this last to a threefold cause in the male sex, viz.: a more abundant secretion of semen, a greater facility for erection, and a lively stimulation of the brain; the two first depending on the extreme readiness with which the blood is brought to the genital organs.

Such as we have described them, are those individuals attacked by hypertrophy of the heart, without pain and obstruction to the course of the blood. They are by it rendered liable to many diseases. The too violent impulse of the blood on the brain exposes them to profuse nasal hæmorrhages, cerebral congestions, epilepsy, and

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* When the growth is very rapid about the epoch of adolescence, the heart, compelled to extraordinary action, undergoes an almost continual super-irritation, by which it is exposed to hypertrophy, attended by hæmoptysis and pneumonia, and sometimes chronic phlegmasiæ of the parenchymatous structure of the lungs, running into phthisis pulmonalis.

apoplexy. In the lungs the same impetus, and the plethora to which such subjects are prone, expose them to sanguineous congestions, which, like those of the brain, are brought on by violent passions, over-running, undue exertions, venereal excesses, stimulating *ingesta*, and are announced by pneumonias, hæmoptyses, or fits of asthma, which are distinguished in this particular, that they are speedily cured by bleeding. The habitual congestion of the digestive viscera renders them liable to acute gastro-enteritis. The subjects of whom we now treat, have, in all their inflammatory complaints, a very hard and much more frequent pulse than other persons, and even preserve these peculiarities during the period of convalescence, in spite of the return of appetite and strength. The heart at last becomes disorganized, if the necessary precautions are not adopted.

We refer to what has been said above of these disorganizations; and must now inquire into the manner in which they modify the circulation of the blood.

Perpetual obstruction to the course of the blood must naturally exist in all cases in which the heart is softened, dilated, weak, or hardened, or its proper arteries ossified, or it attacked by hernia or laceration of its fleshy columns, or the openings of the arteries narrowed or obliterated by vegetations, &c. Independent of the dyspnœa, oppression, and fear of suffocation produced by these obstacles, they also give rise to a forced delay of blood in the venous apparatus of the viscera, livid countenance, an intolerable cough, and mucous expectoration, wakefulness, and even the impossibility of circulation and locomotion, gastritis, and finally general dropsy, under which last these unfortunate beings generally sink. In order to explain the extreme oppression brought on by exercise, we must remember that the muscles, in a state of contraction, drive into the veins and propel towards the heart, a much greater quantity of blood than usual. Now, whenever the heart has lost its energy, it is incapable of freeing itself from this increase of blood; hence augmentation of the dyspnœa, and the necessity under which the patient is to suspend muscular action, in order to relieve himself. We must moreover remember, that locomotion diminishes the free play of the chest, in order to furnish a fulcrum of a more solid kind for the respiratory muscles: but how can there be any curtailment of the extent of respiration, in unfortunate creatures who never have enough of air, without the dyspnœa which already torments them being aggravated. It is for this reason that the re-

cumbent posture is to them insufferable, and they are in consequence deprived of the renovating influence of sleep. They are finally unable either to lie down, or move an arm, or swallow, or even speak, without a redoubling of that suffocating oppression which must finally end their days.

Section XV.—*Alterations in the Arteries.*

Let us next inquire into the diseases of the arteries. It was for a long time imagined, that the too violent impulse of the blood sent by the heart against the arteries was adequate to produce their dilatation, especially at that part called the *bifurcation of the aorta.* Without venturing to deny this fact, I must needs still think that this dilatation, usually called *aneurism of the aorta,* is the product of inflammation. We find it in fact in all parts of the general arterial tree, and always attended by an alteration of the coats of the arteries, precisely similar to that usually produced by a phlegmasia.

Inflammation may penetrate by many channels into the coats of the arteries; sometimes it is directed there by blows, falls, violent muscular efforts; but this cannot take place, except in the superficial arteries, and the membranes. At other times inflammation insinuates itself by means of the capillary vessels, thence to ascend to their trunks, and even to the heart. It is thus that we meet with arterites, after pneumonias and gastro-enterites, as occurring in certain epidemics. It may likewise doubtless happen, that the inflammation developed in the internal membrane of the heart extends even to a considerable distance into the aorta. Particular observations are yet wanting to elucidate sufficiently these facts—though from analogy we may regard them as very probable.

When the inflammation is great, and much diffused in the apparatus of centrifugal vessels, it cannot fail to be very soon mortal, though we find it difficult to characterize it with precision. Pain in these vessels is very obtuse, and if tissues endowed with more sensibility be inflamed, it is impossible to recognise it. We are taught, however, that its signs are strong and hard pulsations, with a swelling and burning pain perceptible in the course of the superficial arteries. I do not believe that the strength of the pulse can be made to depend solely on the inflammation of the arteries, but I am not surprised that attention has been directed to this symptom, since it so often accompanies inflammation of the internal sur-

face of the heart. I have always remarked, that in acute phlegmasia of the arteries, the superficial veins were engorged and livid, a symptom always remarkable after death, and accompanied by large ampullæ on different regions of the skin, in those especially in which the veins are most numerous.

But how can arteritis produce engorgement of the veins and ampullæ, if the capillary system does not participate in the inflammation? I am of opinion, therefore, that this phenomenon is not limited to the large arterial branches; but that it prevails, no doubt, with more intensity in the small vessels, the venous or arterial nature of which is uncertain, and produces in them the same effect as a rubefacient or a blister: the blood must of course be called from all parts to these tissues, take perhaps a retrograde course in the adjacent veins, remain stagnant in them, and produce together with *ampullæ* the varicose enlargement of which we spoke. In this manner are the viscera gorged and inundated with blood and serosity, and finally so disorganized as to become unfit for the performance of their functions. Sufficient attention has not been paid to observe the extent to which inflammation of the very vascular organs may penetrate in the arterial and venous vessels; if we were assured that it always extended some distance, we would cease to be surprised at finding it sometimes reach the heart.*

* Some physicians, relying on a statement of Peter Frank, have attempted to refer inflammatory fever, which they were at a loss to dispose of, to an inflammation of the arterial system; and hence seemed to justify the term of *angiotenic* affixed to this pretended idiopathic or essential fever by professor Pinel. But the symptoms of arteritis are not those of this fever. What is an arteritis which terminates in from one to seven days, without any consecutive lesion? Why, besides, should those authors tell us that, when this fever is protracted, it is changed into an ataxic, or adynamic one, or into pneumonia? Is it not evident that the words *inflammatory fever* only designate a slight shade of gastro-enteritis in a sanguine subject? Arteritis is much more tenacious than the ephemeral fevers, or simple synocha; and if they were always produced by it, why do we see them converted into diseases which were never thought of being attributed to arteritis? I do not say that this last cannot exist with the symptoms thought to characterize synocha: on the contrary, I believe, from experience, that it may be superadded to inflammations of all the large viscera, in certain cases not yet well defined; but of what we are most assured is, that whenever fever ushered in by the usual symptoms of the pretended angiotenic fevers, terminates easily and promptly by sweats, we can never show that it was arteritis. The disorder of the circulation is of a very different intensity from that in angiotenic fever. When so prolonged as to pass into adynamic gastro-enteritis, &c. the arteritis may be associated with it, since it may coincide with the other disease; but in such cases this is not what constitutes the essence of angiotenic fever. Arteritis is then but a complication of the gastro-enteritis constituting this latter fever, a complication by which it becomes

I do not know whether inflammation of the arteries, at first general, may not sometimes remain of a local nature by a kind of imperfect resolution, or whether it may not have been circumscribed in some parts only of the arterial apparatus: be this as it may, we unquestionably meet with such; they are always chronic, and constantly unappreciable. The inflammation passing from the internal membrane soon gains the other two coats of the artery, thickens and engorges them with lymph, hardens, ossifies, and at times contracts them: in other cases the softening which they undergo, renders them susceptible of dilatation produced by an impetus of blood, and the efforts of the adjoining muscles. If these derangements occur in the arteries of the extremities, there results an aneurism purely local, which exerts no influence over the general circulation. If many arterial branches are converted into the same state in different parts of the body, we find the disease appear in different regions, and require a repetition of the operations resorted to in such cases. This is what has been called by physicians the *aneurismatic diathesis.* But if the chronic inflammation attacks in preference the parts of the aorta adjacent to the heart, the general phenomena arising from the obstructed circulation are produced in the same way as in the organic affections of this organ.

The change in the aorta may then be of two kinds: in the first we have inflammation, which, by diminishing the caliber of this vessel, keeps up a perpetual obstacle to the discharge of blood from the heart, to the injury of this viscus, which, thus overloaded by its natural stimulus, contracts irritation, and passes into the state of hypertrophy. In the second kind, the aorta, softened by chronic inflammation, yields to the impetus of the blood which the heart incessantly drives against it, or dilated, while it at the same time becomes thicker, it forms an aneurism of varying extent,* commonly near the heart, sometimes in the middle of the chest, and even in the abdominal cavity. I have seen the bifurcation of the aorta so enlarged by these means, as to obliterate the mouths of the

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much more alarming, is opposed to a favourable termination, and aids in giving it a fatal character. On the other hand, we find, that angiotenic fever really terminates in a putrid fever, unaccompanied by arteritis. There is no reason therefore for regarding this phlegmasia as the cause of fever, which, even though it should depend on it, would not therefore be essential or idiopathic.

* Dr. Fallot, physician at Namur, has communicated to me a case of chronic inflammation of the aorta, in which this vessel was thickened, tuberculous, and even ulcerated in several places. This fact is given in the *Annales de la Médecine Physiologique, tome* 4, page 325.

subclavian and carotid arteries, and of the arteria innominata, whence followed complete cessation of the pulsations in all the arteries of the face, neck, and thoracic members. The patient could not walk without experiencing giddiness and lipothymia: he was pale, and weak, and ate little; but suffered no pain. He died suddenly in a syncope. I deposited the morbid parts in the anatomical cabinet of the hospital of the Val-de-Grace. I regret not having ascertained whether the disorders of this soldier did not originate in an acute disease; but I can imagine that this is no uncommon occurrence, for it seems to me that all violent inflammations communicate more or less irritation to the vascular system. Why should we be surprised at it, since they act so powerfully on the heart? Cannot the irritation under which it then suffers by sympathy, be participated in by the arterial system, and ought we to be surprised that it occasionally existed in a chronic degree in some parts of this vast apparatus?

We ought also to learn whether chronic inflammations which commenced in the skin, or in the absorbent and locomotive apparatus, under the names of *herpes, scrophulas, syphilis, rheumatism,* and *gout,* have not sometimes a tendency to reach the arterial vessels, and thus also produce all the above disorders. We shall not, however, be surprised to find that inflammations of the arteries are more frequent than those of the veins, as it is generally admitted that the former system of vessels is much more abundantly supplied with nerves than the latter, receiving them as it does from the viscera, which are also all subject to inflammation.

Section XVI.—*Disorders of the Capillary Circulation.*

We shall find, on examination, that the disorders of the capillary circulation are extremely numerous. Of these, without doubt, the principal is inflammation, which originates much more frequently in the capillary net-work than in vessels of a certain caliber. I have just said that it could be transmitted along these latter, and even reach the heart; but here I must direct attention to the congestions of this system, which do not attain the height of inflammation: they always originate either in irritation or an obstacle to the course of the blood, whether this be near or remote from the centre of the circulation, or in the heart itself.

Those which proceed from irritation would always rise to inflammation, if the viscera in which they are seated did not undergo

such a derangement of function as to bring on death. This is what has been called by physicians in later times *apoplexies,* because they have compared such congestions to those of the brain: it is one of the most violent disorders to which the circulation can be exposed. We see it without any preliminary inflammation of the brain and lungs, caused by moral affections, which we know irritate prodigiously the viscera, and also after very violent exercises. But more frequently these congestions have been preceded by a slight irritation, which, sometimes inflammatory, though not febrile, prevailed in a chronic degree; it all of a sudden acquires force by the causes already enumerated; the blood is driven with violence into the viscera in sanguine habits; it passes from the vessels which carried it, and is extravasated in larger quantity than usual between the particles of animal matter, or in the interstices of what are called *primitive fibres,* and then the functions of the viscus are interrupted. If this latter be a secretory organ, and communicate externally, it may be preserved from disorganization by a hæmorrhage. In this way hæmoptysis has frequently dissipated pulmonary congestions. But if there be no passage for the elimination of blood from an important organ, as the brain, hæmorrhage, so far from being advantageous, is fatal. Sometimes also the discharge takes place by means of the serous membrane of a viscus, which still leaves us some hopes in the case of the pleura, when the evil is limited to one side of the chest; but these serous hæmorrhages are not less unfavourable to the brain than those which take place in its medullary tissue.

The flat and membranous viscera are less exposed to these kinds of congestions than the parenchymatous ones, though even they are not always safe, since we find the digestive organs occasionally suffering under them. If the hæmorrhage in such cases takes place by the mucous surface, the cure is easy; but if it be poured out on the free surface of the peritoneum, or even in the inter and sub-peritoneal tissue, death comes on suddenly accompanied with great pain. A similar remark applies to the uterus. I have seen this result produced by falls, and violent bodily commotions. Moral causes may also give rise to it in very sanguine and irritable habits. We know how a state of hypertrophy and aneurism of the heart can give effect to the causes capable of producing visceral congestions.

Congestions of a similar nature are sometimes formed in the external tissues, such as the skin and cellular membrane; and they are especially observable in women in whom the menses have been

accidentally suppressed. These persons are all of a sudden covered with red or black spots, without any antecedent inflammation, constituting what has been termed the *morbus maculatus*. It is an extravasation from *error loci*, but still originating under the influence of irritation. There ensues no disorder of the general circulation, and the large viscera do not suffer from it. The absorption of the extravasated blood may take place without inflammation, but sometimes this latter comes on, and phlegmon is the consequence.

External violence is likewise productive of this effect by contusing the smaller vessels, as we see in what is called *ecchymosis*.

It would be useless to repeat here, that whenever a portion of the sanguineous mass is thus accumulated in a tissue, the blood brought by the vessels and directed to the congestion is not admitted. We have already treated of this point when speaking of the capillary circulation in general.

Some physiologists have asserted, that a simple reflux to the remaining portion of the vascular apparatus, of the blood which was directed towards a congestion, could so derange the circulation as to affect the motion of the heart; and that fever would be the consequence. I do not believe that we can admit the existence of such fevers of somewhat a mechanical nature. So long as the congestion, whatever it may be, is not followed by an inflammatory irritation, the heart is not made sensible of it: this we know in congestions produced by a mechanical obstacle to the course of the blood, as in pregnancy, voluminous tumours of the abdomen, effusions in the chest, &c. Do we not meet constantly with persons, who are so affected by these causes, suffer from dyspnœa to the extent of suffocation, without any febrile movement surpervening? If, therefore, fever at times follows irritative congestions, it is because the same irritation which produced them is converted into inflammation; but never does the forced and purely mechanical delay, whatever it may be, give rise to the febrile state, unless indeed extensive lacerations become inflamed, or that masses of extravasated blood undergo a putrefactive movement, which shall perform the office of a stimulant and produce inflammation.

Section XVII.—*Changes in the Veins.*

The circulatory movement in the veins may be impeded in various ways: and first, inflammation of the capillary system may, as we have just seen, extend to them; again, the veins of the surface

are not exempt from external violence, the necessary effect of which is to inflame them. As yet we are without a precise measure of the extent to which this cause may affect them. These vessels are unquestionably interested in extensive phlegmasiæ or œdematous inflammations of the sub-cutaneous tissue. This kind of lesion merits our attention; for inflammation is commonly tenacious in the vessels, on account of the facility with which it is propagated beyond the point in which it originated. In such cases we find a varicose state with a marbled skin covering the seat of inflammation, and associated with these may also exist *ampullæ* and a singular abundance of lymph.

But of all the diseases of the veins, the most frequent, beyond all doubt, is the varicose state, which is most generally the effect of compressions retaining the blood in these vessels. The external veins are most exposed to it, because they are not, like the internal ones, supported on all sides. Let a compression be exercised in the abdomen on the iliac veins, by pregnancy or any tumour whatever, the branches which pass along under the skin of the thighs, and still more of the legs, will become swelled and varicose. It also happens very frequently that the continued efforts of the muscles of these parts, as, for example, fatiguing marches, prolonged standing, occasion varices:—they are even found to originate in very many persons without our being able to refer them to any extraordinary muscular effort—and we can only account for it in the natural weakness of the vessels, which yield to the impetus of the blood ascending against its own gravity. After all, whatever may be the cause of the varices at the surface of the body, they are seen to pass into inflammation, producing always a phlegmono-erysipelatous affection, which is very prone to gangrene, or which at the best leaves behind it ulcers called *varicose*, to cure which is very difficult.

If varices are the cause of inflammation they may also be the effect of it, as we see every day in hæmorrhoids. Formerly the hæmorrhoidal tumours were represented as always primarily varicose, and the flux was attributed to rupture of the dilated veins. Notwithstanding the writings of Stahl, this opinion was long prevalent in the schools; so difficult is it to eradicate old prejudices. It is true that the active character of many other hæmorrhages was conceded to that author; but the one before us was ranked among those of a passive nature. At one time the cause was supposed to be found in engorgement of the abdominal viscera, especially of the

liver, or obesity of the omentum and mesentery; and at last we were told of debility and predominance of the venous system, necessarily brought on by the decline of life, and which alone could explain the production of hæmorrhoids. I have myself heard Bichat deliver this antiquated theory. Finally, however, people yielded to evidence, and the hæmorrhoidal flux is now placed among the active hæmorrhagies. It is admitted that irritation determines an afflux of blood to the inferior portion of the mucous membrane of the rectum, and that sanguineous effusion is one of the effects of this state. Such is unquestionably the case, and this extraordinary accumulation of blood often occasions the dilatation of some veins, the rupture of which may be productive of a very dangerous hæmorrhage.

We have examples of the veins participating in the inflammations of their viscera. This kind of lesion has not been sufficiently studied, nor has it been admitted except when the veins have been found filled with pus, though we know that all inflammations do not end in suppuration. The veins, filled as they always are by a dark blood, from which they derive their colour, are rarely suspected of being inflamed. We ought to observe whether their coats are not thickened, and their *vasa vasorum* engorged, after acute phlegmasiæ of the abdomen. One thing is very certain, that I have often found the vena cava extremely voluminous in those subjects dead from violent gastro-enteritis, with very great sanguineous engorgement of the liver; and I believe that this excessive distention might very well be accompanied by a true phlogosis. Could we but determine this, and mark the symptoms which designate it in the course of those diseases, we should perhaps obtain some insight into their prognosis, and some valuable indications to direct us in the use of local blood-letting, and topical applications.

The vena portæ has been found likewise very much engorged in those who were victims to gastro-enteritis. No inference was drawn from this sanguineous turgescence in the acute form, preoccupied as minds were by the idea of essential or idiopathic disease; but the case was different in the chronic state. To the engorgement of this vein most writers attributed the affections of the liver; and hæmorrhoids, flatulencies, dyspepsia, and hypochondriasis, were in their minds nothing else but an extension of the varicose state of the vena portæ. Though it is very evident that the effect has here been received as the cause, since it is irritation of the intestinal mucous surface that accumulates blood in the veins of the abdomen,

yet we ought not on this account to deny the possibility of a consecutive phlebitis. I believe, moreover, that the engorgement occasioned by the gastro-enteritis may impart a varicose dilatation to veins much less voluminous than the trunk of that called *porta;* for I have found the pancreas enveloped in varices in the body of a man who sunk under the above disease.

We never hear of the inflammation of the pulmonary veins, doubtless because the capillaries of these vessels do not participate in the condition of the parenchymæ, in acute and chronic peripneumonias: it remains however to be ascertained, whether the large trunks near the heart are not secondarily affected by the phlegmasia.

As to the varicose state, it doubtless exists in chronic catarrhs, and aneurisms of the heart and large vessels, which are attended with a stagnation of blood; it is then that the pulmonary parenchyma is liable to be infiltrated with serum, whence results what has been for a long time called *œdema of the lungs.* But it was an error to make it an essential or primitive disease; for never can such a state of things be produced without a forced stagnation of blood, the cause of which we must always regard as an inflammatory irritation of the substance of the lungs, or some obstacle opposed to their disgorgement.

The obstacles to the current of the blood, which have their seat in the heart, retain this fluid in the parenchyma of the liver; and hence this viscus attains to a great size in persons who sink under diseases from the above cause. But an attentive examination will show us, that tumefaction of the liver is due to an accumulation of blood alone, and that the secretory vessels of the bile are not at all enlarged; whereas they are very much so when the volume of the organ is the secondary effect of an inflammation of the digestive canal.

We sometimes find the veins of the brain considerably dilated in consequence of apoplectic congestions and inflammations of the encephalon; but we do not meet with voluminous varices, because the walls of the sinus, strengthened by the dura mater, will not yield to this kind of alteration.

We have elsewhere remarked that violent exercise, long running, &c. greatly accelerated the circulation; and that the heart, no longer able to transmit all the blood brought to it, allowed its accumulation, on one side, in the liver, spleen, and abdominal viscera, and, on the other, in the lungs and head. The veins are, in these

cases, the refuge or reservoir. From this we can understand how important it is for the prevention of hæmorrhages and extravasations in the large cavities where the blood would be decomposed, that all the veins should freely admit of dilatation, and return afterwards to their original diameter; and, likewise, that those of the viscera should be without valves. We have also said, that what produced the greatest relief in these extraordinarily hurried movements, was the reflux of blood towards the surface, and the abundant sweat thence resulting. In spite, however, of this great and powerful aid, nature is sometimes unable to prevent the formation of visceral congestions, which are followed by fatal extravasations, if the blood, forced out of the vessels does not find a vent externally, or by dangerous inflammations.

This would be the place to explain the phenomena of inflammations and hæmorrhages, if we could flatter ourselves with discovering the real essence of those morbid states. Without venturing to promise complete satisfaction on these heads, we will exhibit the view which we are accustomed to take of them. When blood is drawn to a particular tissue by means of irritation, there results a vital erection in this latter; no inflammation has as yet taken place, for vital erections are means necessary to the discharge of the functions; but they must disappear after a certain time. To accomplish this, it is only necessary that the stimulus cease to act in the parts which are the seat of it; but if the stimulus be always acting, the vital erection becomes permanent, and thenceforward assumes a morbid character. It is then an inflammation, if the part be very sanguineous; a sub-inflammation, if it be but slightly so, or rather if it be such that the erection invites more lymph than fibrin furnished with its colouring matter.*

The vital erection once converted into inflammation, the phe-

* I have elsewhere said, (see the Vital Laws,) that those very strong and very permanent erections called *spasm*, repel the fluids; but more attentive observation compels me to recal this assertion, which I had advanced on the faith of others. The first opinion is supported by the circumstance of the spasmodic state suppressing the secretions which the organs are destined to perform; and hence it is inferred that the part is less moistened with fluid, and, as it were, dried up; but we ought to reflect, that if the fluids do not flow or transude from the part in a state of spasm, it is because they are retained there by the irritation. Of this kind are almost all the phlegmasiæ of the highest grade, when in their first period. The afflux of fluids to the tissue affected with spasm is not the less real or continued, and if this state lasts not only in secretory organs, but in a muscle or an erectile tissue, some degree of inflammation is the invariable result.

nomena of organic chemistry are perverted; the organ is at first hypertrophied, and, if the irritation persist, it changes its nature, either by the production of pus, or by being in some other way deterioriated.

The blood, attracted by irritation, keeps up the vital erection, even when the irritating agent which had thus attracted it is no longer present. It is on this account that a state of plethora so powerfully aids the effect of inflammatory agents.—But is not plethora itself a primary cause of phlegmasia? The affirmative reply to this question is very difficult, for we can hardly imagine any person to be entirely protected from the external agents of irritation. Were there nothing else but digestion, it would be enough to provoke a stimulation of the gastric or intestinal mucous surface, and plethora would convert it into inflammation. But how many other agencies torment our organs? Besides, the tissues continually transmit irritation to each other, and that which receives the inflammatory impetus first, is not always the one to retain it. A person of plethoric habit may have contracted a slight or even a violent irritation in the primæ viæ; but if he be exposed to cold, and there follows a bronchial inflammation, from that moment the gastritis disappears, and gives way to a violent pneumonia. A female may be in that state of plethora which precedes the menstrual epoch; and on the discharge supervening, the uterus invites to itself all the irritation of the other viscera. But in other, cases, the vital erections of the lungs or gastric passages having been urged too far by unusual stimulation, the excess of blood, which ought to have been evacuated by the uterus, is drawn to this organ, and there produces inflammation. The head, lungs, digestive viscera, and uterus, are the parts most obnoxious to vital erections beyond the normal state; and on these organs does general plethora usually direct its force. But it must be well understood, that it is equally favourable to the production of a phlegmasia in any other tissue in which an extraordinary and accidental irritation has arisen.

Such is the state of things in irritative congestions, which, when formed, do not, however, always follow the march of inflammation. It may even be affirmed that it enters into the design of nature, to have the blood eliminated rather than remain in the organs in which it had been drawn by too lively an irritation. The uterus is, of all organs, that in which the elimination is most easy, as would seem from its very structure; but for this process to be accomplished, the vital erection in it must not be too intense; for, if it passes certain

limits, the monthly congestion is of itself converted into inflammation, unless the irritated state of the viscus be due to a cause which can supply the place of the hæmorrhage, as in the case of an embryo.

Nature has not formed the other viscera to become the means of sanguineous elimination; but when persons have a good constitution, the congestions of blood in their internal organs give rise to a sympathetic irritation in the orifices of the mucous surfaces, and the equilibrium is restored by nasal hæmorrhage or by a hæmorrhoidal flux. Whenever this event does not take place, it is owing to the debility of the individual, or because his viscera have been too much irritated by his manner of living. Then the congestion of these latter continues, and if not removed, it goes through all the stages of inflammation.

This view explains to us the efficacy of local blood-lettings. If, indeed, at an early period of the attack they be resorted to, on the portion of the skin corresponding to the inflamed viscus, they operate revulsively, and produce hæmorrhages analogous to those which nature always tends to bring on in similar circumstances; and thus they prevent the congestion from degenerating into phlegmasia.

After hæmorrhages of the incipient or forming, come those of the advanced, stage of congestions, and of the epoch when they definitively assume the inflammatory character. We can, it seems to me, attribute them only to a change in the organic action of the inflamed part: but can this change be satisfactorily explained? I dare hardly promise it. I think, however, I have remarked, that an accidental increase of irritation often determines these hæmorrhagies, by suddenly inviting a greater quantity of blood than the diseased tissue can contain; that is to say, more than the transmutations or elaborations of vital chemistry can dispose of. It is thus that apoplexies come on, in persons whose encephalon has been much irritated; effusions in the pleura and peritoneum, already inflamed; hæmoptyses, in subjects labouring under chronic pneumonia; hæmatemeses, mœlenas, and copious bloody discharges, in those long suffering under gastro-enteritis.

To these we must join mechanical causes; as for example, the rupture of a vessel produced by ulceration, unusual efforts, obstacles having their seat in the heart and accumulating blood in the lungs, as also the erect position. Do we not in fact see ulcers of the legs furnishing blood in the standing posture? Doctor Scoutetten, whose sagacity is well known, having suspended several dead bodies by the feet, found that the blood escaped from the inflamed

parts much more readily than those in a healthy condition. He proposes himself publishing the result of his experiments, the like of which no person had before thought of making.

Violent commotions, such as falls, may destroy the contractile power of the vessels,—after which they no longer retain the blood brought to them, and hæmorrhage is the consequence. In this way I have seen the peritoneum filled with blood, and death take place in a short time. At any rate, such causes may leave behind them an irritation which may be converted into a phlegmasia.

We learn then, from what has been said, that when blood is accumulated in a part by any mechanical force whatever, it may be eliminated by extravasation; but it is very remarkable that inflammation does not take place in consequence. By a similar peculiarity it happens, in my opinion, that congestions of the lungs and liver, produced by aneurism of the heart, do not give rise either to pneumonia or hepatitis. When these diseases appear in aneurismatic subjects, they are always the effect of some peculiar irritative agent.

CHAPTER VIII.

OF THE DEPURATIONS.

We must first remind the reader of the uses of the very compound fluid, to which the sanguineous vascular apparatus serves as a reservoir; since besides the part which we have seen it perform in innervation, muscular action, and all the vital erections, the blood serves also to furnish the materials of secretion and nourishment for all the organs.

But to be fit for such purposes it must be deprived of the foreign principles introduced into it, and freed from the superfluous serum, by the aid of which the molecules suitably assimilated had obtained access to its vessels. Our body in fact constantly admits the reception of more matter than is necessary for its support. This superabundance is observed, in the first place, in the digestive canal, which makes a selection, and the residue constitutes fæcal matter. The second separation is seen after intestinal absorption in the de-

purating organs, which hasten to eliminate a superfluous serum, the retention of which would distend the blood-vessels, and oppress all the functions. The evacuation of the superfluous water is therefore one of the first and most important of the internal functions to which we have given the epithet of *organic.*

This explanation cannot be regarded as a hypothetical fact, since after the completion of the diurnal circle, the body, though previously heavier, from the superabundance of absorbed substances, is constantly restored to its accustomed weight and volume. In the period of the most rapid growth, so slight is the daily increase in the bulk of the body, that it cannot be adduced as an exception to the law just laid down. Were it otherwise, there would be no fixed limit to the increase in volume of animals, and animated nature would cease to be what we find it.

Now, depuration consists in this multifarious elimination, viz.: in that of worn out matter and salts detached from the solids, or repelled by the animal fluids, and of unassimilable molecules, such as certain aromatics, resinous, and other principles found in aliments, mineral particles, and finally the superfluous water.

The organs charged with this process are, next to the digestive canal which concurs in it to a limited extent, the skin, kidneys, and mucous surface of the respiratory apparatus.

But may we be allowed to ask how this eliminative depuration takes place? It seems to me that this question is of the greatest importance in its bearing on our studies. Thus, if the fluids eliminated be not endowed with a peculiar power by which they are directed to such and such emunctories, it is very certain that their separation, from the mass of circulating fluids, and their subsequent expulsion, cannot be any thing else but a vital action of these emunctories—and to this conclusion we are forced to assent. It is then indispensably necessary for us to study this vital action in its normal type, to enable us to have an idea of its aberrations, which become so many causes of disease.

Setting out from this undeniable principle, I shall be led to establish, 1. That the three eliminating and depurating organs, which have just been mentioned, are constantly exhausting a certain portion of vital power, and that this exhaustion becomes a habit to the animal economy; 2. That these three organs are always in simultaneous action, but unequally so, and in such a manner that whenever one of them acts more, the others act less, and *vice versa;*

3. That all three alike evacuate serosity, but that each adds to it principles peculiar to itself, and which it alone is required to eliminate.

This laid down, we may next proceed to an examination of the three depurating organs.

Section I.—*Of Cutaneous Depuration.*

I have already noticed the structure of the skin, when examining this envelope as an organ of touch, and we then saw that it was impossible to discover in it vessels specially destined to furnish insensible perspiration and sweat. All that can be advanced with any certainty, is that the vasculo-nervous net-work expanded over the surface of the *cutis vera*, enjoys a vital action, in virtue of which it operates this evacuation. It now behoves us to inquire into what is actually evacuated. Insensible perspiration and sweat are essentially the same thing. There takes place through the cutaneous tissue a continual disengagement of caloric, which carries off with it serosity, holding some salts in solution, mucus, animal oil, and carbonic acid, without mentioning certain aromatics, such as garlic and some others. When caloric disengaged by the skin, is too much loaded with fluids, it deposits them, and the sweat appears in drops. If, on the contrary, the caloric contains no more than it can dissolve, we see only a vapour or gas; but if this gas be collected and condensed in a small space, we are soon assured that it unites all the elements of sweat.

The skin contains likewise excretory canals coming from the glands situated in its tissue: these canals are not so much intended to complete cutaneous depuration, as to furnish an oily humour which coats the surface of the skin, renders it smooth, and protects it in its relations with foreign bodies. This fluid doubtless contributes to render the perspiration unctuous; but it does not furnish alone the oily matter of the sweat (T).

The vital action of the skin is in direct proportion to the quantity of blood which reaches it; and this again is proportionate to the rapidity of the circulation, and the stimulus from external heat. When these conditions are fulfilled to a moderate extent, there is only transpiration or insensible perspiration; in a greater degree this latter is changed into sweat, whilst again in a more exalted stage sweat disappears; such is the general law, confirmed even by facts which seemed to constitute so many exceptions to it. Thus

in certain fevers the product of gastro-enterites, the skin, although of a burning heat, and penetrated by blood, is dry and even arid, notwithstanding that the patient, tormented by thirst, very often makes use of a large quantity of drink, and passes very little urine. Hence the heat and dryness are here coincident in the mucous membrane of the digestive canal, and in the skin. We can, it seems to me, only explain this phenomenon by admitting that the caloric exhaled by the skin is abundant enough to support in a gaseous form all the serosity eliminated from it. What appears a confirmatory fact is, that frequently at this time the cold bath, by cooling the cutaneous envelope, brings out sweat, a proof of the diminished irritation of the skin.

If the skin be covered with sweat, in inflammations of the substance of the lungs, it is because these phlegmasiæ exert an influence over the cutaneous apparatus as irritating as that produced on this latter by the mucous surface of the digestive canal; or rather, it is on account of pneumonia accelerating the circulation, and sending, like muscular exercise, much blood into the tissue of the skin, without imparting to it the same acute irritation as in gastro-enteritis. The correctness of this explanation is shown in the circumstance of that form of gastro-enteritis of itself not painful, or prevented from being so by suitable treatment, allowing likewise of extremely abundant sweats, which are suppressed so soon as the digestive passages are excited by heating drugs.

External cold, and all irritations of the viscera which do not drive the blood towards the surface, diminish cutaneous depuration; the first acts as a direct sedative, driving the blood from the exterior; the second operates revulsively, and invites this fluid to the interior.

All these facts tend to prove, that cutaneous elimination, in order to be accomplished with an energy proportioned to the rapidity of the circulation, requires the skin to be but moderately excited.

When the skin is chilled and pale, the serous evacuation from the surface is usually diminished; but, during this time, we occasionally observe cold sweats. In order to be able to attribute them to the atony, or relaxation of the skin, we ought constantly to meet with them when its vital action is diminished; but as this is not the case, we can only account for them by a peculiar mode of irritation in this membrane, by which it is rendered susceptible of exhaling a serous fluid without being solicited thereto by the superabundance of blood. Such sweats always correspond to the suffering

of certain internal organs, as in the uneasiness of lipothymia, and may, in my opinion, be referred to spasmodic alternations of constriction and relaxation of the cutaneous surface.

Section II.—*Renal or Urinary Depuration.*

The kidneys are double organs, at least with some exceptions, as when a single one is found situated on the lumbar vertebræ, and gives origin to two ureters. They are deeply seated behind the peritoneum, on the lateral portions of the vertebral column, in a line with the two last dorsal and two first lumbar vertebræ, and are surrounded by a cellular tissue, always abundant, and more or less loaded with adipose matter. The kidneys are of an ovoid form, with a concavity at the internal border; and in the fœtus they are surmounted by the renal capsules.

We discover in them two different substances: the cortical and the tubular. The first, or external, is of a brownish-red colour, and penetrates internally so as to embrace the other or second by pillars or kinds of arches; its tissue is granulated, and it contains innumerable sanguineous vessels: to it is attributed the office of secreting the urine. The second, which presents small cones of unequal size, and of a red colour, darker without than within, is composed of an assemblage of small capillary tubes, adhering to the cortical portion by their external extremity, and open on the summit of the cones internally. These cones have a rounded and truncated summit, and bear the name of papillæ; they are penetrated by the orifices of the *tubuli uriniferæ* of the tubular portion, which are nothing more than the excretors of the urine, and which, when subjected to pressure, allow it to escape.

These papillæ are lined by a membrane, which forms the *infundibula*, or *calyces*, and the *pelvis*. The infundibula are small tubes which, by means of one extremity, embrace one or more of the papillæ, and by the other are continued into the pelvis. This last is a reservoir which occupies the centre of the gland, and corresponds, on the side of its free portion, to the concavity of the kidney: it receives all the infundibula in its deepest portion, and by its internal part is continuous with the ureters.

The pelvis and infundibula are formed by means of a proper membrane, whitish and resisting, which is of the fibrous character, and lined internally by a mucous membrane of very obtuse sensibility.

The kidneys are enveloped in a whitish and fibrous membrane, adherent to the cortical surface, and penetrating by the fissure or concavity so as to be reflected over the pelvis, which is, consequently, but a continuation of it.

These organs receive their nerves from the great sympathetic, in conjunction with some filaments from the eighth pair; the blood which supplies them is derived from arteries detached from the aorta, and called *renal* or *emulgent;* their veins correspond to the arteries, and their lymphatics are quite numerous.

SECTION III.—*Physiological Action of the Kidneys.*

The kidneys are, together with the skin, the principal organs for the elimination of the superfluous serum; but the former secrete a fluid called urine, in which are contained many principles peculiar to it; the chief of these is urea, a substance susceptible of becoming acid and forming salts. The materials found in the urine are urea, a gelatinous animal matter, muriate of soda and of ammonia, phosphate of soda and of ammonia, either separate or combined in triple salts, phosphates of lime and of magnesia, phosphoric, uric, and benzoic acids. At times we discover in the urine the sulphates of soda and of lime, the oxalate of lime, the urate of ammonia, silex, &c.

Urine is, then, a very compound fluid; and physiologists usually consider its discharge as the means of eliminating the superabundant salts and molecules which are detached from the solid parts. It has been thought to contain more phosphoric acid than common, when there was a softening of the bones in disease; and those who attribute gout to the loss of the phosphate of lime, which gives solidity to the osseous system, have not been backward in affirming, that the elements of this salt, and even the salt itself, entire, were collected and eliminated by the action of the kidneys; but more recent experiments have not corroborated this assertion. Scudamore, who has analyzed the urine of gouty persons, discovered its resemblance to that of all those who suffer from any febrile movement. Consequently, if the urine becomes more acid, and charged with salts, mucus, and animal matters, in the gouty, we must refer this to the irritation which alters the function of the kidneys: the diminution of the serosity, which is the basis of their secretion, renders it more concentrated whenever the sweating is profuse; whereas, in the case in which cutaneous depuration is suspended, the urine is so much the more limpid, and less charged with foreign particles,

as it contains a larger proportion of serous fluid. This remark has led physiologists to establish as a principle, that the kidneys always discharged very nearly the same quantity of substances other than the serosity, which alone is susceptible of any great difference in its proportion. This conclusion is, in our minds, a very rational one.

Does the urea exist in the blood, or is it formed by the kidneys at the expense of certain principles which they draw from the circulation? This problem is not yet solved. It was at first thought, that the urea was simply collected by the kidneys, and afterwards believed, that these organs prepared it from all that was brought to them; but some experiments have again led to the belief, that it exists in the blood. Still, however, we cannot regard these experiments as conclusive; and we await the result of new ones, before our opinion can be definitively fixed. After all, I do not think that we absolutely require very exact notions on this point, in order to establish the relations between the kidneys and the other organs, and to indicate the manner in which the former become causes of disease.

The secretory or eliminating action of the kidneys is not, like that of the skin, in a direct ratio to the quantity of blood brought to them. Whenever the circulation is greatly accelerated, were it even by muscular exercise, the blood is driven towards the surface; and consequently it is the skin which becomes the chief eliminator of the superabundant fluid: the kidneys at this time supply but a small quantity of urine, much loaded with salts. This is a remark of which the pathologist ought not to lose sight. What most efficaciously augments the urinary depuration, is the coldness of the skin, and we may draw the inference therefrom, that this membrane is associated with the kidneys, by what is called reverse sympathy. But how are we to explain this kind of relation? We see manifestly that whenever external cold, a chill from moral causes, or that produced by visceral irritations, are opposed to the excitement which gives rise to insensible perspiration and sweat, the eliminating function of the kidneys is augmented: these two kinds of excitation are then in an inverse ratio to each other. But it may next be asked, is it the ganglionic nerves which are the directors of this movement of irritation? How shall we venture to advance this proposition, when we can discover no filament of those nerves in the cutaneous tissue? To give it feasibility, we ought to prove that the vital action arrested in the cutaneous exhalents is reflected to the

viscera, which finally direct it to the renal tissue. The first part of this novel assertion is a well-established fact; for we are positively sure that when the blood is driven from the surface, it is always drawn towards the viscera.* The second would in its turn have some weight, if it were proved that the viscera could exercise sway over the kidneys. Let us examine this novel question.

Whenever we desire to excite the flow of urine, we take into the stomach water which holds in solution a small quantity of irritating matters, such as salts, acids, alcohol, acrid substances derived from the vegetable kingdom, or even from animals, as cantharides; for it is well understood that pure water does not pass with equal promptitude by the kidneys. It is therefore impossible for us to deny that a moderate excitation of the gastric sense is not repeated in the eliminating tissue of the kidneys. Let us, however, bear in mind that this sympathy does not take place in a decided manner; the blood is in rapid motion, for then it is always, as we have already

* This is the common language of pathologists, but it does not, we conceive, fairly express the question. To speak of the blood being driven from the surface to the internal organs, by cold, is not to relate what actually occurs. In individuals exposed to cold air, or immersed in cold water, there is a diminution and even suspension of the functions and vital phenomena of the skin:—it is pale, and shrunk, and ceases to exhale either sensible or insensible perspiration: its sensibility is deadened, and the capillary circulation impeded and restricted by the diminished diameter or a collapse of the vessels. What evidence, we would ask, can be adduced of this enfeebled action of the cutaneous system being followed or accompanied by determination of blood to the interior, and congestions in the larger viscera? Is it in the cold air and minor exhalation from the lungs—absence of thirst and heat in the abdominal viscera—torpor of the brain, evinced in enfeebled intellectual efforts and indisposition and inability to thought? The entire series of phenomena in all the cavities are similar to those on the surface:—there is diminished action throughout:—minor exhalation, secretion, and sensibility of all the membranes and glands. In fact there is an utter incompatibility between the symptoms and effects in the brain, lungs, and abdomen, exposed to great cold, and in those evinced in these same viscera when suffering under the undue determination, constituting vertigo and apoplectic tendency in the brain, pneumonia in the lungs, and gastro-hepatic diseases, or cholera, and yellow and bilious fevers in the liver, spleen, and intestinal canal. Cold applied to a sensitive surface of any extent, cutaneous, pulmonary or gastric, by means, respectively, of the cold bath, cold air, or cold drinks, acts sympathetically on the whole nervous system, and of course upon the entire capillary tissue, wherever found, superficial or deep-seated—this tissue is shrunk and collapsed, and the larger vessels are also in a measure enfeebled—there is then diminished propulsive power in the whole circulating system, and a tendency to stasis of the blood in all its ramifications, in whatever part found: but no driving of this fluid from the skin to the viscera. This view of the operation of cold, will be found in harmony with the greater number of morbid phenomena to which it gives rise, and certainly guide us to a more consistent, rational, and satisfactory employment of it as a therapeutical agent.—TRANS.

seen, driven towards the surface, and the stimulation received by the stomach serves only to render the sweat more abundant. On this account diuretics become sudorifics, when taken in warm weather or while going through violent exercise; and sudorifics administered in the cold season and while the body is at rest are converted into diuretics. Now these observations give a high degree of probability to the proposition above laid down; for in cases in which the cold suppresses the exhalent action of the skin, the quantity of blood at the surface is notably diminished, owing to the circulation not being sufficiently accelerated to direct it there, and the mucous surface of the stomach and its muscular tunic acquire a manifest degree of energy, since the assimilating faculty is always augmented in a remarkable manner.

We may then I think admit as an established fact, that the exhalent action, suppressed in the skin exposed to cold, is transmitted through the medium of the digestive passages to the tissues secreting and eliminating urine, and that there exists no direct relation between the kidneys and the cutaneous surface.

The influence of the irritation of the mucous surface of the stomach on the kidneys, only succeeds when moderate in producing an increased formation of urine. So soon as this irritation becomes excessive, the superfluous serosity can no longer be eliminated by the renal passages, but must find an outlet by the skin, either in the form of sweat, or if the surface be hot and burning, as in gastro-enteritis of great intensity, it is exhaled as vapour. But if this disease, though intense, be apyretic, that is to say, if it do not sufficiently accelerate the circulation so that the blood may be driven towards the surface, and if the skin becomes cold, both urine and perspiration are simultaneously diminished; and we always find in such cases that the stomach is averse to the ingestion of liquids, and frequently even to all kinds of *ingesta*, so great is the connexion of action between this organ and the depurating viscera.

The other phlegmasiæ likewise exert an influence over the kidneys: that of the liver, which is always accompanied by a gastro-enteritis, tends greatly to lessen the quantity of aqueous fluid evacuated with the urine; and we find that several of the principles of bile, and especially of the colouring matter, are eliminated by the kidneys; in encephalitis, which is usually associated with gastritis, these organs are modified nearly in the same manner as in the latter disease. Peritonitis puts a stop to the secretion of urine, and as it also diminishes that of sweat, intestinal absorption scarcely takes

place; the ingesta are rejected; all which exhibit a new proof of the intimate connexion between this absorption and serous eliminations. Phlegmonous inflammations, and especially those of the lungs, having this peculiarity, that they propel the blood in abundance towards the surface, whereby the cutaneous exhalation is augmented, must of course render the urine more concentrated. We may say the same of the acute inflammations of the skin, such as the eruptive, which are always accompanied by a phlegmonous turgescence of the sub-cutaneous tissues. Finally, the inflammation of the kidneys cannot but greatly derange their depurative action: those which are acute and phlegmonous suppress it entirely, and sometimes induce in its place a hæmorrhagic discharge; those of a chronic nature, on the contrary, are at times reduced to an irritation of the secretory vessels, which furnish urine in extraordinary abundance.

The moral affections exert a powerful agency on the eliminating function of the kidneys: in fright, the urine is augmented to an astonishing extent,—which can, we think, be attributed only to a certain degree of irritation of the digestive organs, reflected to the plexuses and ganglions of the great sympathetic: and we must remember that in such cases there is always a spasmodic constriction of the skin with a chill, which diminishes cutaneous exhalation; but if the passion be of such a nature as to excite strongly the circulation, and drive the blood towards the exterior, as in fits of anger, the perspiration is augmented, and the quantity of urine diminished.

Would it not seem to result, from all these points of analogy, that these two eliminators, which we have just examined, do not act independently of the viscera; and that, consequently, the modifying causes by which their action is deranged do not perform it by means of a direct and peculiar influence? This is what it greatly behoved us to demonstrate, so as to give their true value, that is what is founded on sound physiology, to the signs drawn from the nature of the sweat and urine, in order to throw light on the diagnosis of many diseases.

The product of the depurative secretion of the kidneys is always accompanied by a mucus which comes from the follicles of the pelvis and bladder: occasionally this humour predominates, as in the cases in which the surfaces over which the urine passes are seized with inflammatory irritation.

Section IV.—*Of the Excretion of Urine.*

The urine, after having traversed the canals called *ureters*, reaches the bladder, where it remains for some time before being finally expelled. Let us glance at the organs destined to excrete this fluid.

The ureters are two fibrous canals, continuous with the pelvis, and lined by a membrane of a mucous nature, analogous to that of the pelvis and infundibula: they are endowed with contractility, to that extent which can be enjoyed by the gelatinous tissues.

The bladder is formed after the same plan as the digestive canal: we discover in it a mucous membrane, furnished with an internal sense of relation, which lines the cavity; a muscular tissue of great strength is united to it, by means of laminated and cellular leaflets: finally, the major part of this organ is covered by the peritoneum, which leaves it to be reflected over the internal surface of the pelvis, and the inferior portion of the muscles of the abdominal parietes.

The mucous membrane of the bladder, having very intimate relations with the encephalic centre, contains in consequence vasculo-nervous matter in a state of sensitive expansion; and like all tissues of this kind it is furnished with follicles, destined to secrete a mucus. This double disposition of parts is especially remarkable in the space comprised between the orifices of the two ureters and the mouth of the urethra, in what is called the *trigone vesical.* It is at this part that the sense is most active, and the mucous secretion most abundant.

The neck of the bladder is embraced, in the male subject, by a large gland called *prostate*, of a structure similar to that of all the secreting organs; and as such we refer to the account of the secretions produced in the generative act.

The ureters of each side enter the bladder at a small distance from its neck, and are in this place covered by the peritoneum; they have entrance obliquely, by penetrating the mucous membrane a little above the point where they pass through the muscular coat.

The vesical apparatus has arteries which come from the hypogastric, and nerves, some of which belong to the great sympathetic, while others are detached from the sacral nerves, which, as we have seen, are derived from the brain.

Section V.—*Function of the Bladder.*

The internal sense of the bladder is not productive of any sensation in the normal state, unless the urine be accumulated to a certain amount in this cavity, so that it resembles, in this respect, the sense of the great intestine, in being intermittent. When the bladder is full, the desire to urinate is felt. This depends on a twofold cause: 1. the stimulation produced by the urine on the mucous surface, and more especially on the triangular region adjoining the neck; 2. the distention of the muscular fibres. The first of these two sensations is the most perceptible, and is evinced in a kind of pricking and tickling, which are referred to the external extremity of the urethra; the second, only manifest when the bladder is greatly distended, consists in a sensation of weight, and as it were, of a foreign body occupying the hypogastric region.

These two sensations make a call on the brain, and instinct determines the will to allow the ejection of urine; but the will may still refuse, and all this is accomplished in a manner which we shall soon become acquainted with. The mechanism of the expulsion of urine has not, we think, been suitably explained. Does it depend on the direct influence exercised by the will over the muscular coat of the bladder, or is it simply produced by the exercise of volition on the muscular fibres compressing the neck, the bladder acting in other respects by a power peculiar to it? The first mode would seem to us inadmissible; the second is alone susceptible of proof, since the urine is evacuated in the new-born child, in the person asleep, the apoplectic, and one in a state of stupor, all of whom are deprived of the power of volition. In all these cases it seems to me very certain, that the ejection of urine is a purely instinctive act; or, in other words, is dependent on the spontaneous contraction of the bladder, which calls to its aid and service the cephalo-splanchnic muscles, with the understanding, however, that they obtain their contractile stimulation from the brain, on which it acts by means of its ganglionic nerves. If, therefore, the adult, when awake and attentive to the sensation of the want, can suspend the indulgence of it, he does it by the intervention of the brain, and in one of the two following ways: 1. By contracting the sphincter of the bladder; 2. By refusing to allow the cephalo-splanchnic muscles to aid in the effort made by the muscular coat of the bladder to bring about the ejection: but, in return, he enjoys the power of seconding this effort, by inducing a contraction of the diaphragm and the abdomi-

nal muscles, stronger than that produced by mere instinct in persons whose intellectual faculties are suspended, and in whom, consequently, there is not the possession of volition.

Such are the modifiers of the bladder in its natural condition; but this viscus has numerous sympathetic relations with many other organs, such as the kidneys, stomach, intestines, &c. which we shall meet with in its pathogenia.

Section VI.—*Pulmonary Serous Elimination and Depuration.*

The internal surface of the bronchiæ, and especially of the air cells, must be regarded as a passage for the elimination of the superfluous serosity, and as an organ of real depuration. In fact, expiration gives issue to a great quantity of water that escapes with the air, in the form of vapour, and which is the bearer of carbonic acid, as we had occasion to learn when giving an account of respiration. This depuration is, indeed, the most important; for, without it, the blood remains black, surcharged with carbon, and totally unfit for the support of the functions. But at present we have to consider pulmonary exhalation as diminishing the superfluous water, and as concurring with the two processes already detailed, to maintain the equilibrium of the animal economy.

This serous evacuation is in a direct ratio to the quantity of blood brought by the artery into the pulmonary tissue;—as a necessary consequence, it follows, that whenever the current of the blood is accelerated, or this fluid driven from the surface, by cold, or any other spasmodic affection of the skin, the pulmonary exhalation will be in greater abundance; and, hence, will be often in an inverse proportion to that of the skin: I say often, for in many instances, both are simultaneously augmented,—as in violent catarrh and pneumonia, in which we see respiration very frequent and the skin covered with sweat at the same time,—a coincidence likewise remarked in violent exercises. It is very remarkable, that at this period the urinary serosity is greatly lessened in quantity; but when the blood is driven from the surface by the coldness of the skin, the increase of pulmonary exhalation corresponds with that of the urine.

It follows, moreover, from this, that pulmonary exhalation may be at times increased, together with augmentation of the cutaneous discharge, and at times with the urinary; but that this latter is never in quantity correspondent with the increase of sweat.

The phlegmasia of the different organs do not act by a peculiar sympathy on the exhalent orifices of the bronchial vesicles. We shall at first find that they increase or lessen the pulmonary depuration by accelerating or retarding the course of the blood ; then that in irritations of the viscera which are of such a kind as to suspend or retard the respiratory movements, as in tetanus, peritonitis, and certain gastrites which bring on attacks of asthma, the blood though accumulated in the lungs does not lose so much serum, and is not so completely depurated, as in the natural condition.

As regards moral causes, they can only act in one of two ways ; those which retard the action of the heart and the respiratory movements, must of course diminish the pulmonary exhalation, whilst those which accelerate the circulation, such as joy, and anger in its period of explosion, will never fail to increase the evacuation.

When we speak of visceral irritations, whether inflammatory or nervous, or the product of moral causes, which retard the respiratory movements, we do not mean to intimate that they act immediately on the muscles. Their first impression is always directed to the pulmonary sense, which resides, as we have seen, in the tracheo-bronchial membrane ; it is this impression diffused throughout all the splanchnic nerves, and transmitted to the brain, which provokes the contraction of the air cells, opposes the enlargement of the parenchyma, and retains sympathetically the action of the inspiratory muscles, which cannot as we have seen be at variance with the surface of the lungs.

It is however not the less certain, that these modifiers diminish pulmonary depuration by lessening the number and extent of the inspirations and expirations, and not by closing the exhalent orifices by a spasm *sui generis.*

The mucous secretion is associated with the depuration of which we are now treating, in the same way as it is with that of the urinary organs, and as the sebaceous matter is associated with that of the cutaneous transportation ; it is performed in the trachea and bronchial branches, by means of follicles readily observable; but it is very difficult to distinguish them in the pulmonary vesicles, though these latter be furnished with mucus, and this humour aids that of the bronchiæ in giving some consistence to the vapour issuing from the chest. Notwithstanding this, however, its transparency is not affected, as we may readily convince ourselves by examining the icicles which are formed on the beard of persons who travel in the open air during cold weather. If this exhaled fluid be tasted,

it is sharp and saline, as well as the sputa of the thickened mucus sometimes expectorated during a state of full health; but we never discover in it any fat or oily matter, such as the skin and kidneys habitually furnish. Hence each depurating organ is charged with the function of evacuating, together with the superfluous water, the principles peculiar to it. If then they can be auxiliary to each other on the score of the balance of fluids, they can never become so in reference to depuration properly so called.

Section VII.—*In what manner the Action of the Depurating Organs becomes the cause of Disease.*

We have admitted the existence of two fundamental facts in the depurative functions: 1. The waste of vital action; 2. The evacuation of a certain quantity of fluids. It is therefore from the derangement of these two orders of phenomena, that the diseases result of which we are now to seek the causes.

Whenever the exhalation from the skin is increased to an extraordinary degree, as in the case of copious and continued sweating, there supervenes an irruption of small red pustules of an inflammatory character and accompanied by a great itching: they are called *sudoral pustules:* they may be converted into erysipelas, or phlegmons, or carbuncle, and be attended with all the effects of these phlegmasiæ. We likewise find them occasionally giving rise to real herpes, especially if the physician take it into his head to treat them by hot bathing and diaphoretic drinks. In all these cases the irritation is not limited to the exhalent tissue, but is participated in by the sebaceous follicles, the action of which is exalted conjointly with that of the tissue. Another effect of excessive sweats is the habit acquired by the skin of giving them out by the slightest excitation. I have seen many examples of obstinate sweating after the long use of sudorifics: this discharge throws the patient into extreme debility, and is very difficult to cure, because its suppression gives rise to visceral irritations. Whenever the cutaneous exhalation is checked by the sedative action of cold, or by a chill proceeding from any other cause, the excitation of the skin must be replaced by that of some other part; and its place is usually supplied by the depurations from the kidneys and the pulmonary vesicles. If, now, this transfer of irritation be made with too much impetuosity, nephritis, catarrh, or pneumonia, may be the consequence; and, if the irritation received by the parenchyma of the lungs reach the

serous membrane, pleurisy is of inevitable occurrence. Here, then, we have the transfer, though a normal one, of the cutaneous irritation, converted into disease; but in numerous other instances, this same transfer is abnormal, that is, in place of being reflected to the internal depurations, irritation arises, by an error loci, in other tissues, which again is productive of disease. If it be directed on the mucous membrane of the digestive organs, a gastro-enteritis or colic will supervene; and in case it should not stop at this part, it may fix itself on the liver, and give rise to hepatitis; or it may even traverse the digestive canal, and exhibit itself on the serous membrane of the abdomen by producing a peritonitis. The portions of mucous membrane lining the eyelids, nasal fossæ, mouth, fauces, pharynx, and larynx, may also contract this supplementary irritation, and we shall then see the attacks of ophthalmia, coryza, gingivitis, aphthæ, amygdalitis, pharyngitis, and laryngitis also called croup. In the female, the same aberration may produce uterine catarrh, or suppress the excretion of the menstrual blood, and become the cause of metritis, or even inflammation of the principal organs of the abdomen, chest, or head, or other parts on which the hæmorrhagic irritation will be directed.

But the irritation which has just abandoned the skin is not always transferred to the mucous membranes; it may affect the synovial and tendinous capsules, and the inflammation thence resulting will receive the name of *gout;* or else it will take place in the tendinous, aponeurotic, or muscular tissues, and give rise to rheumatism: if the glandular and cellular tissue of the mammæ be boundaries of this transmission, an event of ready occurrence after child-birth, because at that time these organs are in an excited state, a phlegmon of the most painful character will be the result. In other cases, we shall find the parts affected by the sedative impression on the skin to be the superficial lymphatics, and the sub-cutaneous tissue of any region of the body; and there will follow glandulo-cellular inflammations, of varying intensity, which will produce vast collections of matter; or which, passing into the chronic state, will keep up an œdema, deforming the part. Such, in the opinion of Dr. Alard, is the elephantiasis of the Arabs. Finally, the encephalon itself may, though less frequently, become the abnormal assistant to the skin; and apoplexies, paralyses, phrenites, and insanities, will be the consequence of a chill of the cutaneous surface. We know that sanguineous apoplexies are tolerably frequent during great frosts.

The transfer of cutaneous irritation having once taken its direction towards an organ or tissue, it is very common for it to follow the same course at each recurrence of the sedative action of cold on the exterior. Such, in my opinion, is the reason why relapses from diseases occasioned by this cause are so frequent, and of such ready occurrence. Those who have had a cold never cease to catch fresh colds, and their lungs become studded with tubercles; the gouty and rheumatic relapse on the slightest diminution of temperature, &c. The animal frame becomes habituated to this kind of irritation, which assumes a chronic character; the depuration is not completely performed; the fluids are unceasingly invited and accumulated in the interior; nutrition is depraved, and wonderful disorganizations are brought about in the cellular, lymphatic, and parenchymatous tissues, &c. This is what may be very conveniently seen in the post mortem examinations made in cold and temperate climates, whereas those who sink under disease in hot climates, exhibit the cellular and parenchymatous tissues dried and wasted; and more frequently humoral congestions are only met with on the digestive mucous surfaces, and in the brain.

We see, now, how many obstinate and dangerous diseases may ensue from the torpor of the skin; still, however, they are nothing more than the effect of the transfer of the cutaneous irritation presiding over the evacuation of the superabundant water. There are others depending on the morbid course given to the fluid itself. It will be seen, that I speak of the vicious increase of secretion, and of dropsies. Thus, whenever an internal organ contracts inflammation after the torpor of the skin, the whole fluid of perspiration is not drawn towards it; but it reacts on the viscera, which latter bring into action the supplementary depurating organs; so that there only remains to the one inflamed its own irritation, in virtue of which it acts on the blood or the lymph, as if it had been irritated by any other cause than by cold. Cases may indeed present themselves, in which the exhalent action suspended in the cutaneous tissue is replaced by a secretory or exhalent one independent of the inflammation. It is in this way that cold produces bilious and bloody vomiting, mucous diarrhœas, salivations, very abundant leucorrhœal fluxes, ascites, and even general dropsy taking an extremely rapid extension.*

* These secondary effects of cold, and others mentioned by the author, in the preceding page, are susceptible of ready explanation, without admitting an afflux of blood

If we pass to diseases in which we recognize for causes the diseased actions of the kidneys, we shall find these organs contracting irritation, not only in consequence of suppressed cutaneous exhalation, but even from the long-continued use of diuretics; for the kidneys by dint of excitation acquire, in common with the skin, a vicious habit of hyper-secretion. Diabetes may therefore be the consequence of this order of things, and rarely does it exist without a shade of inflammation. Among the modifiers, the operation of which is specifically on the kidneys, we shall mention cantharides, balsamic and terebinthinate substances, uva ursi, the alkalies, and soap, the prolonged use of which may lead to renal irritations of a very dangerous nature. Physicians generally, now-a-days, are of opinion, that the abuse of vegetable food, and saccharine drinks, which pass off too readily by the urinary secretion, is adequate to the production of diabetes. The urine at such times is deteriorated; it no longer contains urea or animal matter, and holds in solution a small proportion of salts, but it has suspended in it sugar in a particular state. I do not know whether this œtiology be well established; but I have seen cases of saccharine diabetes which did not depend on the above cause: they were entirely the consequence of an inflammation attacking simultaneously the mucous membrane of the stomach and the tissue of the kidneys.

The causes diminishing the formation of urine, render this fluid very concentrated, as we have already seen. There thence results an irritation, exerted on the mucous surface of the pelvis, ureters,

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to the affected parts, from the skin. All the internal surfaces and secretory vessels of the glands, promptly sympathize with the cutaneous envelope, when it is exposed to cold. The action of all parts is diminished synchronously;—and all, as in the case of the skin, react, and experience a glow and additional injection of the capillary tissue. The appearance of the skin, after the body has passed from a cold to a warm medium, is a good measure of that of that of all the other parts. But these are not capable of enduring the alternate chill and glow to which, by constant habit, the skin is reconciled:—they suffer from congestious, increased secretions, and, at times, hæmorrhage, during the period of reaction. The suffusion and increased sensibility of the extremities, after preceding torpor from cold, is to apt to be represented internally be pleuritic stiches, rheumatic pains, catarrh, bronchitis, hæmoptysis, diarrhœa, dysentery, &c. In all these cases the morbid state is simultaneous with, or directly consequent on, the state of reaction, glow and increased excitement, and is never associated with, or caused by, the primary sedative operation of cold. The internal organs do not suffer during the paleness and shrinking of the skin, however long and severe they may be, but during the period or reaction and heat. The effects of cold cannot then, compatibly with the rules of logical induction, be referred to the reflux of blood from the skin to the viscera. We have shown in a former note, p. 423, that no such reflux takes place; but even if it did, it would not be a cause adequate to the production of the subsequent phenomena.—Trans

and bladder, which is soon converted into inflammation. The formation of gravel, occasioning attacks of nephritic colic, is another consequence of this mode of irritation. We meet with them in fact in robust persons, who, relying on the vigour of their stomachs, indulge immoderately in the use of strong food, high-seasoned dishes, and who drink undiluted red wines, highly charged with tartaric acid, and a colouring principle. The urine of these persons is much loaded with urea, salts, and animal matters; it is readily decomposed, and forms calculous concretions, and the excretory canals which give it passage take on inflammation.

The kidneys receive, moreover, irritation by the sympathy that unites them with the bladder and the genital organs: on which account gonorrhœa, when it has traversed the urethra and reaches the bladder, produces inflammation of this latter, which is continued to the kidneys. Excessive venery also produces nephritis without vesical inflammation being observed.

The kidneys we are told become heated, and subsequently inflamed and gravelly, by the person being much in bed. This would seem to us to depend on the concentration of urine and inertia of the bladder, which retains and allows the urine in its cavity to be concentrated by absorption.

The inferior part of the rectum is likewise associated in action with the kidneys, whence must result frequently the transfer or propagation of the hæmorrhoidal irritation to these organs.

The mucous surface of the kidneys and the rectum, is not by any means protected from a catarrhal irritation originating in those parts by the influence of cold: it is a very powerful cause of the formation of calculi. This kind of phlegmasia is distinguished by the great abundance of mucosity in the urine, accompanied by pain in the region of the kidneys, but without any sign of vesical inflammation. The renal organs may, finally, receive irritation from the muscular tissue, to which itself had been transferred the impression of cold on the skin.

The causes of disease of the bladder are frequently the same as those of the kidneys which we have just spoken of, and which are either produced by sympathetic influence or by the irritation of a too concentrated urine; but the bladder has some peculiar to itself. As a reservoir for the urine, it may suffer from the forced delay of this fluid, which losing its serum by absorption becomes too irritating to its mucous membrane. It may likewise be injured by its extreme distention, the sad consequences of which are inflammation

of its neck, too frequently united to a palsy of its muscular tissue. The bladder may also, as an organ sympathizing with the skin, contract an internal inflammation following cold, which is one of the most usual causes of catarrhus vesicæ: its proximity to the vesiculæ seminales, and the rectum and vagina, expose it moreover to participate in the irritation of those parts.

The calculi of which the bladder is the recipient may come from the kidneys; but it is very possible also that they are the results of a particular mode of irritation of its internal membrane causing the decomposition of urine. We all know that any foreign body introduced into its cavity serves as a nucleus for a calculous concretion. After all, whatever may be the origin of vesical calculi, their presence is always annoying to the bladder; and it may be said while on this subject, that we can only hope for a complete cure by the operation of lithotomy, provided the bladder has not been disorganized by the prolonged irritation it sustained from those foreign bodies.

There is no irritation of whatever nature it may be, or in other words, whatever be its primary seat and intensity, which cannot be transported to the bladder; and what favours these kinds of metastasis, is the state of super-excitation in which this organ is so frequently met with from the causes already enumerated. In fact, the abuse which we make of the genital organs, syphilitic irritations, the inconsiderate use of gastric stimulations which always become so for the kidneys, and neglecting to evacuate the urine at proper times, in the end impart to the cystic tissue an irritability which multiplies its relations with the other parts of the animal economy, and renders it susceptible of being the seat of metastases which would never have reached it, had it not deviated from its normal degree of function. Consequently, those who wish to prevent the gout, herpes, and other affections of the external parts of the body, from being transmitted to the bladder, ought to turn to account what we have just elucidated, and husband an organ, without the integrity of which there is no complete happiness in life.

Whenever the bladder is filled with urine which it is unable to expel, pain is experienced and extended to the large intestine, in which it produces a very inconvenient evolution of gas. We see in this case the effect of a real sympathy exerted on the colon; but there exists reciprocity between these two organs, for in flatulent colics the bladder very rarely fails to be disturbed in its function. Inflammations of the pelvic peritoneum, and of all the organs conti-

guous to the bladder, give rise to a retention of urine, unaccompanied by vesical phlegmasiæ; but this is only because the movements of the bladder increasing the pain of the diseased parts, instinct retains this viscus in a state of immobility. Practitioners ought never to lose sight of this by no means unfrequent cause of the retention of urine.

The intellect exercises, in certain cases, a marked sway over the bladder; as in the instances of shame or timidity. This mental affection prevents us from gratifying the desire to urinate; and it would therefore seem that the bladder is susceptible of being influenced in this respect similarly to the genital organs and the rectum. Timid persons cannot urinate in the presence of others; a power which they are unable to control, constricts the neck of the bladder, so that it does not yield to the pressure of the diaphragm and abdominal muscles. The effort produced by the contraction of these parts, causes the discharge of some drops of urine; but so soon as it ceases, the bladder no longer contracts to expel the remainder. This is among the number of those causes that produce inflammation of the neck, and a paralytic distension of the fundus of this organ.

It is worthy of remark, that whenever an inflammation of the urethra retains the urine in the bladder, on account of the pain which its passage would give rise to, the renal secretion is greatly diminished. This fact of general notoriety in gonorrhœa evinces a very active influence exerted by the viscus which serves for the deposit over that secreting the urine: dilatation of the ureters and inflammation of the kidneys are the consequence.

The existence of a mucous membrane furnished with an internal sense in the duct of the ureters, affords an adequate explanation of the pains and convulsions of the limbs, brought on by renal calculi, while passing down to the bladder. We have a right to infer from this, that the excretory ducts in question receive branches from the cerebral nerves: but sympathetic irritations springing up at the same time in the intestines, in which gas is evolved and colicky pains felt; in the stomach, which eructates violently, and is contracted even to the degree of producing vomiting; in the cremaster muscle, which draws up the testicle to the abdominal ring; in the the spermatic cord, which, together with the testicle, becomes painful; in the diaphragm, and, in a word, in the whole visceral apparatus of the abdomen, seem all conclusively to prove, that the great sympathetic contributes to the vitality of the mucous membrane of the

ureters. As similar phenomena are evinced by the inflammation of the pelvis of the kidneys, we cannot deny them an organization precisely analogous. Do not these views serve to corroborate the opinion which we advanced above, when we said, that the entire visceral apparatus concurred in the transfer to the kidneys and their dependencies of the irritation which it received from the skin, at the time that this envelope was subjected to the sedative influence of the external cold?

Excessive pulmonary exhalation is not an appreciable cause of disease; but the irritation producing or suddenly increasing it after a chilling of the skin, may, by being transmitted to the follicles, the tracheo-bronchial membrane, the parenchyma, and the pleura, be converted into an inflammation, as we have already remarked when treating of the alternate states of perspiration and the flowing back of blood from the surface to the viscera. Whenever a cause of the nature of those indicated is opposed to the complete performance of inspiration and expiration, pulmonary depuration is defective; and then the blood remains serous and carbonated, and returns partly in this state into the aortic circulation. There results from this, uneasiness, feebleness, a notable diminution of irritability, and possibly, an œdematous state of the lungs. Are we not justified in suspecting that the retention of pulmonary serosity contributes, sympathetically, to the general dropsy which is consecutive to that of the parenchyma, in the cases of continual dyspnœa produced by certain catarrhs, and the influence of a chronic irritation of the digestive passages? ought we not, in consequence, to infer the indication for diuretics to supply the want of pulmonary exhalation? This is my opinion; but the attention to husband the sensibility of the stomach ought to guide every physician in the employment of these remedies, which are always more or less stimulating.

We have not yet sufficiently observed, whether in certain bronchial inflammations, in measles for example, the phlogosis be not opposed to the depuration of blood in the lungs. Recent experiments have shown, that the section of the pneumo-gastric nerves, (eighth pair,) rendered aeration and digestion of very difficult performance. This fact proves, be it said incidentally, that the nerves of the great sympathetic require the aid of the brain in order to support suitably the action of the viscera. In the above cases pulmonary depuration must be impeded.

For the better understanding of the phenomena of depuration, I shall now glance at the effects of certain poisons.

When a noxious substance is introduced, through the stomach, into the animal economy, as in the instances of acetate of morphia, putrid meat, certain poisons, it first gives rise to irritation of the gastric passages; all the sympathies linking these with the other viscera are awakened,—such as the pain and oppression of the head, pain in the limbs, accelerated pulsations of the heart, dry and burning skin, a suspension of the urinary and mucous secretions; finally, after a febrile and uneasy state, of varying duration, but which seldom exceeds twelve hours, all the depurators are opened simultaneously; many of the secreting organs, and especially the mucous cryptæ, associated with them, participate in their mode of excitation. We find appearing at the same time, copious sweats, urine depositing a sediment, sero-bilious stools, sometimes salivation, and often an abundant secretion furnished by the mucous follicles of the tracheo-bronchial surfaces.

How can we explain such phenomena, without admitting that the irritation exercised on the internal sense of the stomach is diffused throughout the entire apparatus of the great sympathetic and the brain, and that the stimulation reflected and transmitted repeatedly from one order of nerves to another, finally terminates by a super-excitation of the depurating, and many of the secreting organs, which, opening like the former on surfaces of relation, may become their coadjutors or substitutes? Does not this fact confirm anew the opinion of the skin being associated with the kidneys through the medium of the visceral nervous apparatus,—always aided in its function by the excitement of the brain? I mean to say, that this organ, put into play by stimulus from the viscera, reacts on the great sympathetic, and imparts to it sufficient energy to revive that of the heart, propel the blood towards the skin, excite the action of the kidneys, and even combine with these if necessary, the bilious, salivary, and mucous secretions.

But a circumstance no less worthy of our admiration is, that even when the poisons of which we have spoken, or other similar substances, have been introduced into the course of the circulation, by injecting them into the veins, or by absorption after their insertion into the flesh, the effects have been precisely identical with those detailed above. M. Magendie relates, in his journal, experiments which place this subject beyond all doubt, and M. Orfila has obtained similar results. It is always by an irritation primarily developed on the digestive surface, propagated to the brain and to the apparatus of ganglionic nerves, and accompanied by the most

usual symptoms of gastro-enteritis, that nature prepares the depurative evacuations by means of which the elimination of foreign unassimilated bodies is accomplished; she could perform nothing without this combination of irritative movements. The gastric passages and the ganglionic nervous apparatus are therefore the instruments which she is always obliged to wield, when she is powerfully disturbed. The irritation of the brain alone would produce merely impotent convulsions; the heart would not act, or it would only do it to a trifling extent, were it only brought into play by cerebral influence; it would indeed force the blood towards the surface in such a manner as to excite sweat, as in the case of muscular exercise, but the kidneys and glandular organs in general would not participate in the action of the cutaneous exhalents. No, we repeat, the brain and heart irritated by it alone would never succeed in placing the depurating and secreting functions in such a condition, as to enable them simultaneously to give issue to the matters troublesome to the animal economy; the great sympathetic, the regulator of the vascular movements, must direct influx towards the interior of these organs, in such a manner as to render them fit at the same time for secretion and excretion, and not so as to throw them into a state of spasm or of inflammation.

But let us take up this last idea. Whenever a poison operates with too much violence, the depurative secretion does not take place; the cause of this I find in the inordinate irritation of the gastric viscera, which is productive of a double effect: 1. That of concentrating action in them by inflammation; 2. That of paralysing the brain by inviting to it too large a quantity of blood, whence results either the comatose state, or convulsions, by which the strength is finally exhausted.

I have not yet however said all on this interesting subject, and who can ever exhaust it? Even though there should be no foreign matter to eliminate, the effects of strong stimulations of the animal economy would still be the same, and be accomplished as follows: In the same way that we cough, or sneeze, or make efforts to urinate, or to go to stool, in consequence of simple irritation of the mucous surfaces of the bronchiæ, of the nasal fossæ, rectum and bladder respectively, without there being any matter on these surfaces, the evacuation of which is necessary, so also does it happen, that the stimulation of the principal organ of digestion, the centre of the chief cords of the great sympathetic, excites a series of irritative movements, which, if not arrested by too powerful a gastro-cerebral

congestion, will finally terminate in an evacuating process of the eliminators, and frequently of the secreting organs which act as their auxiliaries. It is thus that a paroxysm of intermittent fever terminates in sweating, and that moderate gastritis ends in evacuations of every kind.

The reason of all this is, that neither elimination nor depuration are the object of all these combined efforts in the febrile state. They take place by sympathies which unite the action of all these organs, because such is the natural course of irritation; beginning in a certain organ, and in a certain degree, it must terminate in a certain corresponding manner; and, in the case before us, this termination is the definitive transmission of irritation to the secretory organs, whether there be a peccant matter or not in the body. In the normal state, this irritation serves to eliminate the products of digestion, together with the effete portion of animal matter, and so far it is unaccompanied by any febrile disturbance; but when the system is affected in its centre of excitability, this irritation is attended with a febrile movement, not because there is much matter to evacuate, since the efforts are the same whether there be foreign bodies to be expelled or an ordinary depuration to be performed,—but because the movements, which were only in miniature in the normal state, become very much magnified, on account of inflammation.

We see, from this, how gastro-enteritis is the basis of all the varieties of typhus, and why malignant fevers, of all kinds, have always been confounded with those of a sporadic, putrid, and adynamic character.

I shall say nothing of the corrosive poisons introduced into the stomach or injected into the veins, for the rapid disorganization produced by them does not allow of the system's putting forth its conservative efforts. Nux vomica, taken into the stomach in small quantities, may excite the reaction spoken of above, but in larger doses it engorges the brain and spinal marrow, by giving rise to sanguineous exhalations in the arachnoid, and convulsions, which are speedily mortal. In fine, all the poisons, in small doses, cause depuration, whilst, in larger portions, they kill by disorganizations and convulsions.

It follows, as a consequence of all these views, that it is not a critical depuration that ought to engage the attention of physicians in the treatment of acute phlegmasiæ, but the arresting as soon as possible of excitation raised above the natural standard; when this is appeased, if depurations be necessary, they will very easily

take place without any violent efforts: none such are required for eliminating the matters badly assimilated, which are so abundant in the system when suffering under scurvy and chronic phlegmasiæ, or what is called a state of *cacochymia*. So soon as we have succeeded in quieting the irritation of the part opposed to assimilation, this last is accomplished with regularity, and all the depraved juices are eliminated without the supervention of new disturbances.*

To conclude now by a more immediate recurrence to our subject, we will say, that diseases are never the effect of a want of power in the eliminators, excepting always those of the lungs, but rather proceed from an abnormal or morbid irritation of the viscera, which deranges the action of the eliminators; and that the danger resulting is due less to the retention of substances to be eliminated, than to the consequence of visceral irritation. If we admit an exception to this rule, in favour of pulmonary elimination, it is because there the danger is in consequence of the privation of a stimulus,—oxygen, indispensable to the well being of the animal economy; and not as the result of an excitation tending to an inflammatory state.

I have been compelled always to associate the secreting organs with the deranged function of the eliminating ones; but when studying the former in a more particular manner, we shall find that they have their peculiar causes of disease. Be this as it may, we cannot deny that the history of the eliminating will naturally prepare us for that of the secreting organs.

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* The whole of this paragraph ought to be a subject of daily meditation to the physician, who desires reason to guide, and success to follow his practice. He will be led to ask himself whether it be necessary and proper to produce by his emetico-cathartic, or diffusible stimulant and tonic medicines, a perturbation of the whole system, similar to that resulting from poisons and the worst causes of disease. Will he find his excuse in the hope to discharge peccant matters, by vomiting and purging, when he himself created the irritation which provoked to their formation? Or can he promise his patient that the quiet and ease which follow a true crisis shall result from this treatment? He will hardly find in stimuli and tonics a means of allaying the compound perturbation of disease and of prior medication. He may, indeed, by these means increase and even cause exaggerated sensations in various organs, followed by morbid sympathies; but he does not remove or quiet the primary irritation, which finally becomes more diffused and complicated in its nature.—Trans.

CHAPTER IX.

OF THE SECRETIONS.

The secretions consist in the formation of certain humours, which are to concur to the performance of many functions. The organs charged with this task are designated under the general name of *glands*. These are more or less regularly spherical; some presenting but one body of varying volume, others an assemblage of glandular grains, united by cellular or laminar tissues, forming a complex gland. All glandular structures, whether large or small, receive an artery proportioned to their volume, with a corresponding vein, and nerves, of which some come from the great sympathetic, and others emanate from the brain, or its spinal prolongation.

For the convenient study of the secretions, it is necessary to associate them with the functions of which they are the completion. Let us see then what are the offices to which the secreting glands are annexed.

In taking a retrospective view, we find first the sebaccous and oily secretions, which concur both to sensitive and eliminative functions; after that, we see the mucous secretions, which are connected with the internal senses, and depurative eliminations, and the lachrymal secretion, which appears very analogous to the mucous.

Passing afterwards to the digestive function, we shall there find the secretions destined to assimilation, and which we shall study, commencing with the sense which prepares for this very important function. Such is the order that we propose following in this chapter, reserving for that of *generation* the secretions which serve for reproduction and the nourishment of the new being.

Section I.—*Of the Cutaneous Secretions.*

These secretions are confided to glands situated in the very tissue of the skin itself, of which they are folds, in form of a *cul-de-sac*, and in which the epidermis appears to dip down to form a canal whereby the humour reaches the cutaneous surface. They are called *sebaceous* glands, because their unctuous product is compared to fat; they are very apparent on the nose, forehead, scalp,

about the lips, and especially at their angles, in the hollow of the arm-pits, on the groins, in the vicinity of the nipple, and around the anus; although they are not found in the other regions of the skin, analogy leads us to place them there: sometimes, indeed, they can be distinguished in certain individuals, in some places where they do not appear in many others; often also irritation suddenly renders them sensible in places where before it was impossible to perceive them. Finally, the presence of the sebaceous matter itself over the whole cutaneous surface, appears to leave no doubt of the existence of organs charged with effecting its secretion; but it remains to be ascertained, whether the portions of animal matter which produce the humour in question must necessarily be disposed in rounded corpuscules, and in a glandular form, in order to be able to fulfil their functions.

The sebaceous fluids consist of a mucous or albuminous matter, connected with an odorous and volatile principle, which varies according to the particular region of the body. The fluid called *cerumen*, which is secreted by the external meatus auditorius, is regarded by M. Vauquelin as a compound of albumen, thick oil, and colouring matter.

Section II.—*Of the Mucous Glands.*

The mucous glands, called also *follicles* or *cryptæ mucosæ*, are to the membranes of that name what the sebaceous follicles are to the skin, that is to say, folds of the mucous membrane in form of a *cul-de-sac*, whose orifices open upon that membrane. These follicles have not yet been discovered over the whole surface of the mucous membrane; but here, as in the case of the skin, analogy leads us to admit them. It is not long since they have been discovered in the pituitary membrane, where their existence had been denied. Be this as it may, we shall make the same observation upon these glands which was made on the sebaceous, viz.: that the impossibility of making an exact dissection of the capillary tissues does not allow us to discover all the forms of animal matter; but wherever a particular humour is found in a tissue, we are forced to conclude that this latter is organized in such a manner as to be able to produce it; and when in place of one humour we meet with many, we must acknowledge that the tissue is complex. Such is precisely the case with the mucous membrane of the digestive canal, and especially of the stomach, which could have a form of animal matter

calculated to furnish digestive juices, although no gland destined to that purpose is discoverable. Nature has made no engagement with us to give the glandular form to all that can impress particular characters on the mobile and circulating animal matter. It is in the glands called *amygdalæ,* that we find collected in greatest number the tissues secreting mucus: they are, as we know, situated between the pillars of the arch of the palate, and the glandular acini which compose them are united by means of an areolar tissue, and covered by a mucous membrane, which bears the same relation to them that it does elsewhere to tissues of a similar nature. Generally, in all points where the hollow organs which contain mucous membranes are contracted, the follicles are much more numerous.

The mucus is analogous to vegetable mucilage, and contains in addition azote.

Section III.—*Of the Lachrymal Gland and its Dependencies.*

The *lachrymal gland* secretes the tears, which are carried by the alternate movements of the depression and elevation of the superior eyelid over the whole surface of the eye, and afterwards conducted towards the great angle by the contractions of the orbicular muscle, which has a tendency to approach towards its fixed point of attachment. The tears are pumped up by the *puncta lachrymalia,* introduced into the *ducts* of the same name, then into the *lachrymal sac,* and the *nasal canal,* and finally into the *nasal fossæ.*

The *lachrymal gland* is situated at the anterior, external, and superior region of the orbit, in a slight excavation of the os frontis; it is of an oval form, of the size of a small bean, and composed of rounded granulations of a whitish colour, lightly tinged with red; it is enveloped by a cellular capsule, which furnishes to its interior, numerous processes that serve to separate the globules from each other. This gland has excretory ducts which open on the internal face of the superior eyelid—difficult to be seen in the human subject, but distinguishable with little trouble in the larger quadrupeds: lastly, it receives a nerve of the fifth pair, and an artery, and gives origin to a vein.

The ocular orifices of the lachrymal ducts are called *puncta lachrymalia;* they are in number two to each side, situated at the great angle of the eye, on a small tubercle of the internal extremi-

ties of the eyelids; they are, consequently, divided into *superior* and *inferior*.

The *lachrymal ducts*, which are continuous with them, have a direction, at first, the superior upwards, the inferior downwards; afterwards, they both incline inwards, and approaching and coming together, or isolated, they open into the *lachrymal sac*.

The *lachrymal sac* is a small membranous, oblong pouch, situated at the great angle of the eye; its internal wall is formed by the lachrymal gutter, hollowed out of the ascending apophysis of the superior maxillary and lachrymal bones, and the external by an aponeurosis; the inferior presents an opening of communication with the *nasal canal*. This latter, situated behind the ascending apophysis of the superior maxillary bone, descends backwards and inwards, and opens into the inferior meatus of the nasal fossa, below the anterior extremity of the inferior cornet.

The puncta lachrymalia and ducts, the lachrymal sac and nasal canal, are lined by a mucous membrane which is continuous with the conjunctiva and the pituitary membrane.

The *caruncula lachrymalis* is a reddish tubercle placed at the great angle of the eye, behind the internal commissure of the eyelids; it approaches in its functions to the *glands of Meibomius*, a species of follicles situated on the border of the eyelids, and destined to secrete a particular kind of mucus.

The tears are saline; they turn vegetable blues green, contain a large quantity of water, hold in solution a gelatinous animal mucilage, and possess a small quantity of the muriate and phosphate of soda, pure soda, and phosphate of lime.

Section IV.—*Secretors for Digestion.*

Of the Parotid Gland.—This gland is situated beneath the concha of the ear, in a deep excavation which exists on the side of the face, between the posterior edge of the ramus of the lower jaw, the external meatus auditorius, and the mastoid apophysis of the temporal bone, and extends from the zygomatic arch to the angle of the jaw; its form is that of an irregular pyramid, the base of which is turned outwards. This gland is composed of granulations united by a compact cellular tissue, each of which gives origin to a small excretory canal, which unites to the neighbouring ones to form a larger branch; these again unite with others, and terminate all in

one trunk, of about a line in diameter, which is called the *parotid duct* or *duct of Steno.* This duct leaves the gland to pass over the masseter muscle, which it traverses transversely, and opens in the mouth, on a level with the second superior molar tooth; its interior is lined by a mucous membrane.

The parotid gland receives nerves from the facial, the fifth pair, and the cervical plexus, and arteries which are detached from the surrounding branches.

Of the Sub-maxillary Gland.—This is situated at the internal side of the ramus and body of the inferior maxillary bone, in the space left between the two bellies of the digastric muscle; it is sometimes elongated in an outward direction as far as the *parotid*, with which in this case it communicates. Its tissue is similar to that of the latter. It has an excretory canal called the *duct of Warthon*, which opens on the sides of the frenum of the tongue; its nerves come from the fifth pair and the sub-maxillary ganglion.

Of the Sublingual Gland.—This is placed in the thickness of the inferior part of the mouth, beneath the anterior wall of the tongue; it is of an oblong form from before backwards, in a direction parallel to that of the opposite side. Its organization is like that of the former gland; it has no common excretory duct, but many small ones which open separately in the mucous lining of the mouth. Its nerves are furnished by the fifth and ninth pair.

Anatomists do not say that the salivary glands receive nerves from the ganglion of the great sympathetic; it is however evident, that these nerves pass to them, in company with arteries having the same destination.

The saliva is composed, according to M. Berzélius, of water, a peculiar animal matter, mucus, the alkaline hydrochlorates, acetate of soda, and pure soda.

Of the Liver.—This gland is situated in the right hypochondrium, which it entirely fills, and in the right part of the epigastrium, below the diaphragm, and above the stomach and the transverse colon; it is elongated transversely, is thick and voluminous at the right extremity, but thin and elongated at the left. The diaphragmatic surface is smooth and convex, and divided into two parts, of which the left is the smaller, by a duplicature of the peritoneum called the *suspensory ligament.* The abdominal surface is irregularly concave, and presents three lobes separated by fissures; the right, or *great lobe,* which lodges the gall-bladder in a slight excavation; the small lobe, *lobulus spigelii,* situated behind;

the left lobe, of a middle size, placed entirely to the left, and more or less extended towards the spleen. These different parts are separated, 1st, by an antero-posterior fissure in which is lodged the umbilical vein, and which separates the left from the right lobe; 2d, by a transverse furrow through which passes the vena portarum, and behind which to the left is placed the lobulus spigelii. The vessels of the liver are the hepatic artery, a considerable vessel which is detached from the aorta; the vena portarum, which dips down between the two eminences of the concave face, called *portæ;* and the hepatic veins. These latter open by many separate trunks into the vena cava ascendens, immediately below the diaphragm: they carry back the blood of the hepatic arteries and of the vena portarum. The hepatic nerves are furnished by the pneumo-gastric, or eighth pair, the phrenic, and the great sympathetic.

The proper tissue of the liver is composed of granulations of the size of a millet seed, of a dull red hue, and of a soft consistence.

In the middle of these granulations wind the ramifications of the vena portarum, and of the hepatic artery and duct—the whole enveloped by a cellular membrane, called the *capsule of Glisson,* which is but the continuation of that immediately covering the exterior surface of the liver, and which separates it from the peritoneum. The excretory ducts of the liver, after being detached from each granulation, are united to form the hepatic duct, which is directed towards the duodenum; before it arrives there, it is met at a right angle by the cystic duct which comes from the gall-bladder. The two unite to form one, which bears the name of *ductus communis choledochus,* and opens into the duodenum with that which comes from the pancreas. The bile does not get into the gall-bladder until after the union of the two canals, that is to say, by ascending against its own weight. The ductus communis choledochus does not penetrate the duodenum before its having passed for some time between its mucous and muscular coats. The peritoneum covers the liver at all parts, except at the excavation of the gall-bladder, the two inferior fissures, and the posterior edge.

The bile is formed of water, albumen, mucus, picromel, a kind of resin, or of a substance that Berzélius considers as a compound of an acid and of picromel, hydrochlorate of soda, phosphate and sulphate of soda, and lastly, phosphate of lime and oxide of iron. It is only from recent experiments that picromel has been admitted, for its existence in the bile had been denied by M. Thenard.

Of the Pancreas.—This gland is situated at the posterior part

of the epigastric region, upon the vertebral column, behind the stomach, and to the right of the spleen; it is elongated transversely, and is thinner at its left extremity than at its right or *head,* called also *small pancreas.* Its tissue is analogous to that of the salivary glands; being of a whitish gray colour, and composed of granulations which are very visible to the eye. We see in it the ramifications and branches of the excretory ducts which open into the duodenum separately, or united to the ductus choledochus. The nerves, that are distinguishable, are branches of the great sympathetic.

Section V.—*Of the Functions of the Organs of Secretion.*

The word *secretion* means a separation. Indeed, the general opinion at first was, that the molecules of the humours which are furnished by the glands exist in the blood, and that they are separated therefrom by vessels for the purpose, which proceed from the arteries, and which are called *collateral* or *secerning.* The glands were considered as congeries, formed by the capillary arteries which are continuous with veins of the same kind, and by the collateral canals. It was thought that these last afterwards united to form canals of more considerable size, called *excretors,* which conveyed the secreted humour to its place of destination.

This is, doubtless, a very simple explanation of the phenomena of secretion; but is it corroborated by dissection and by chemistry? To this question it is impossible to answer in the affirmative. It is not by dissection; for, although we can find in a gland, vessels charged with the humour which it elaborates, we cannot be certain that these vessels have extracted it from the sanguineous capillaries, since the extreme thinness of both sets does not admit of our demonstrating these anastomoses. We cannot say, that the blood is not extravasated, and does not pass molecule by molecule through the parenchyma of the gland, instead of traversing it in small columns in vessels, such as those of which our senses give us an idea.

Secretion by means of collateral vessels is not demonstrated by chemistry, since the analysis which has been made of the blood does not lead to the discovery of all the principles that are found in the products of the glands. The bile and the semen, (I might also say the urine, for the kidneys are ranked with the glands,) are humours which do not exist in the blood, if they have not first been formed by their respective glands. It is the same with cer-

tain very odorous humours that are met with in many animals, as those of the civet cat, and the beaver, the black liquor of the cuttle-fish, and the poisons that are furnished by the viper and other venomous animals. The same fact is met with in vegetables; but I shall not apply it to animals, though I might be justified in doing so.

Since we do not find in the blood the principles constituting the essential character of the humours furnished by the glands, it is impossible to admit merely a simple selection in the tissue of these latter, or a simple separation of molecules, which were previously disseminated through the circulating fluids, and which require only to be united in order to form a peculiar matter.

Modern physiologists, sensible of the full force of this objection, which they themselves started, have not hesitated to abandon the theory founded on the use of the word secretion. It would therefore be useless to refute the opinions of those who explain secretion by the affinities of form and volume, between the molecules to be secreted and the mouths of the secreting vessels; and likewise of those who think to give an explanation by supposing in these vessels the pre-existence of the humour, which attracts the molecules that resemble it, at the time of their passing over their orifices. These hypotheses have fallen into the discredit they merited, and simple secretion is no longer admitted: the word alone remains in the science, though it has changed its meaning. The existence of the proper vessels is still admitted—but they are charged with the office of preparing the fluid of each part out of the materials they derive from the blood. It is then a new composition, a transformation of fluids, that the word secretion represents to the physiologists of our day. Let us examine this opinion.

This transformation, or this new composition, cannot be questioned: it is one of the operations of organic chemistry: but if dissection does not show the direct opening of the vessels, (in which the small masses of the proper humours are detected,) into the blood-vessels; if this opening is a hypothesis, the formation of the humour by secreting vessels cannot but be equally so. I have already said, when speaking of the capillary circulation, that we cannot believe the fluids to be always contained in vessels, having other vessels within their parietes; and that it was absolutely necessary to admit an extravasation of the molecules of mobile between those of fixed animal matter. Now, I think that it is in that extravasation and filtration of blood, particle by particle, through the glandular parenchymæ, that these separations and transformations of

circulating matter take place, by which a portion of it is made to appear with attributes that it did not before possess.

To this it may perhaps be replied, that such an assertion is hypothetical. I regard it however as an inference much better founded than that which had been proposed, since it rests upon an incontestible fact—the absolute necessity of the extravasation of fluids at the extremities of the blood-vessels. Indeed, this necessity is demonstrated by the nutrition of all the tissues; for it is not possible to suppose secreting vessels, on account of the fixation of albumen, gelatin, fibrin, and the salts, in the different tissues which they form. But if extravasation is necessary for nutrition, why should it not be so for the formation of fluids? It will doubtless be replied, "Why should it be so? Could it not so happen, that the transformation of the fluids should take place in a portion of mobile matter, isolated from the general circulating current, in the interior of the secreting vessels?"

I think it impossible formally to deny this other mode; but it is a hypothesis, and I regard it as less probable than the inference which I have laid down, because the changes of form in the mobile matter, and the chemical compositions of the living body, must be accomplished with a facility proportioned to the smallness of the filiform structure, and because the most minute portions of this latter are precisely those in which the fluids are no longer collected in masses and contained in vessels.

The grounds of my opinion are these. The free particles, when extravasated, are in more complete contact with the primitive fibre, and can receive the transforming vital influence more readily, than when they are collected in compact masses in the vessels. I have another reason to offer on this subject: it is, that a certain repose is necessary to the play of chemical affinities: now, that repose, or at least that retardation of progress, is more considerable in the extravasated fluids than in those circulating in the vessels. The vessels, according to my view, are destined to conduct the fluids, and not to change their form. I think, on the contrary, that they must, to a certain degree, preserve their peculiar qualities; for absorption, which could alter them, is scarcely performed in the excreting vessels. Whenever nature wishes to concentrate a fluid, she deposits it in a reservoir, and there removes from it whatever is superfluous, whilst the residue combines and acquires by repose the qualities necessary to the performance of the function for which it is destined.

Let us examine now the glands when in a state of action, and see in what manner they concur to the completion of the functions to which they are annexed.

Section VI.—*Of the Action and Use of the Sebaceous Follicles.*

The sebaceous glands act in an uninterrupted manner; but their action is increased whenever the skin is stimulated by friction, and when the circulation is accelerated. The humour which they furnish serves to render the skin unctuous, whereby the impression of external bodies is more easily tolerated, and the preservation of the temperature of the living body aided; since all fat substances are known to be bad conductors of caloric. It is by it that the epidermis is impermeable by water, which collects into drops in place of first soaking the cuticle. This humour in condensing forms a kind of layer, so that, when we wish to clean the skin, we use warm water and a soapy or alkaline substance, which dissolves this fatty matter. Notwithstanding this, when the skin remains a long time immersed in cold water, the sebaceous humour is finally dissolved, in consequence of the salts which that liquid contains, and the epidermis is allowed to imbibe the latter, and swells, whereby the cutis is placed in contact with the water, which is absorbed and enters into the circulation. This solution does not take place with amphibious animals, aquatic birds, &c. because the cutaneous oil is with them more abundant, and more decidedly fatty, than in the human species.

Section VII.—*Of the Action and Uses of the Mucous Glands.*

The mucous glands are likewise in continual action, which is increased by the stimulation of the membrane to which they appertain, much more than by the accelerated circulation of the blood; though they receive from it also, at least in its normal state, an increase of secretory impulse. The mucus which they furnish presents itself to mitigate the hardness of contact of external bodies, and combines with them when they are liquid. The mucus is of such a nature that it can be absorbed and assimilated; it is discharged only when superabundant, but it is always mixed to a certain extent with the fæces and urine. It also comes off with the blood in the hæmorrhagies of the mucous membrane; in the bronchial vesicles; it is partly dissolved in the expired air; in fine, it is a

humour having multiplied and very important uses. It is found in great abundance in waters which are on the surface of the soil, on account of the numerous animals that inhabit them. The mucus collects after the evaporation of these waters, during the application of heat; it afterwards putrefies, and affords emanations which blend and combine with those of animal and vegetable substances deprived of life. This is a circumstance which should never be lost sight of by those physicians who direct their attention to the study of epidemics, and of medical topography.

Section VIII.—*Of the Secretion of Tears.*

The lachrymal gland is in continual action; but this is augmented under two circumstances worthy of notice: 1. When the conjunctiva is inflamed or irritated by a foreign body, a mode of increased action common to it, with all the other glands obedient to the stimulation of the surfaces of relation on which their excretory canals open: it is necessary to remark, that the excitement of the retina, by the rays of light, communicates to the conjunctiva an irritation, of which the lachrymal gland partakes; 2. When man is a prey to the depressing or commisserating affections, the lachrymal secretion is increased. If we are to judge from the observation of that which can be appreciated by our senses, I think it will be admitted, that the irritation can only arrive at the gland by pervading the mucus surface from the throat to the eyes. Upon reflection, I think I can affirm, that in many cases the irritation pervades the sensitive surfaces of the mucous membranes, in the same way that horripilation does that of the skin. The contraction of the muscular tissue adhering to these membranes always follows, and the blood accompanies it. It is thus that in the depressing passions an irritation is generated in the epigastric centre, which spreads to the pharynx, and causes the blood to flow, with an increase of sensibility, toward the portions of mucous membrane which line the nasal fossæ, the lachrymal duct, and the surface of the orbit of the eye. I know that in these kinds of painful paroxysms, the depression of the diaphragm is incomplete, that the blood retained in the breast is opposed to the return of that brought back by the jugular veins, and that an engorgement of this fluid must consequently be formed in the brain. But how is it that these efforts, which produce the same stagnation in the encephalon, will not give rise to a flow of tears? It is, doubtless, because there is in the depressing passions another

modification than that of the violent efforts, which we know to be purely mechanical. Now, this other modification appears to me to be the irritation of the mucous surfaces of the pharynx, nasal fossæ, and eyes; it is it which causes the afflux of blood into those tissues; which engorges them, as the augmentation of their secretory action proves; and which produces the same effect upon the lachrymal glands, and determines their super-secretion. Whenever this takes place, the absorbent action of the puncta lachrymalia is increased, and the tears flow in abundance into the nasal fossæ; hence the frequent necessity of blowing the nose when one cries; but that does not prevent the increase of the mucus by an influence peculiar to the pituitary membrane. It is an opinion generally adopted, that the flow of tears is a solace to the unfortunate; this depends upon the visceral irritations of the passions subsiding, like other irritations by a humoral evacuation. Tears would, then, be the natural crisis of the affections which excite them. This opinion was sustained by one of my pupils, in a memoir *ex professo;* but he had no idea of the progression of irritation along mucous surfaces. I think it very useful in the explanation of many physiological and pathological phenomena, and hope that it may be approved of by physiologists.

Section IX.—*Of the Physiological Action of the Salivary Glands.*

The salivary glands secrete very little when the mucous lining of the mouth is not irritated, and the small quantity of saliva which they furnish descends insensibly along the œsophagus into the stomach. But, whenever mastication is exercised, or the interior of the mouth is in any manner excited, the stimulation is communicated to the salivary glands, and the saliva is poured out in abundance by the organic action, or the contractility of the excretory ducts. To this, without doubt, the action of the muscles of the jaw contributes, either by the pressure which they exercise upon the glands, or by the uncommon flow of blood which they produce in all the vessels of the face: but this cause is far from having all the influence usually attributed to it; for when the lining membrane of the mouth is irritated, without mastication being exercised, the saliva does not cease to flow in great quantity. This may readily be observed in smokers, and all those who have an inflammation in the cavity of the mouth.

We know that the sight or recollection, or, in other words, the idea of dishes which please the sense of taste, likewise determines the super-secretion of the saliva, which is then, as it were, injected into the mouth; I think that the irritation which produces this effect is communicated by the brain to the organ of taste, whence it is conveyed into the salivary glands, and made to pervade the interior of their excretory canals. This mechanism then appears to me analogous to that of the flow of tears by a moral cause.

In transports of anger, the saliva is secreted in abundance, and remarkably altered; it is poured into the mouth, where it appears thick and frothy; at the same time that the muscles of the inferior maxilla are convulsed, which produces the gnashing of the teeth. Now the first impulse of this singular mode of irritation appears to me to come from the brain, which acts upon the pharynx and palatum molle. It is from these parts, according to my view, that the irritation is propagated to the salivary glands; and if it be true, which we cannot doubt, that hydrophobia may be produced by violent anger, and communicated by the bite of an infuriated individual, we must believe that the saliva is then converted into venomous matter.

The salivary secretion is likewise much augmented during the venereal orgasm, especially in man, and this fact agrees with the observation of pathologists, who have proved that inflammation is readily transported from the testicles to the salivary glands, and *vice versa*. Hence it has been remarked, that the kind of anger accompanying violent desires for coition, which cannot be gratified, has sometimes been productive of spontaneous hydrophobia, susceptible of communication by the bite.

The use of the saliva is very evident: it mixes and combines with the food, by the assistance of the action of the teeth, and gives it its first degree of assimilation. I think also, that, during digestion, the secretion of that humour is augmented to a certain extent, by the irritation which is propagated into the mouth from the lining membrane of the stomach.

If the digestion be natural, the saliva is drawn into the stomach; but when that organ is disagreeably affected by an aliment, the saliva which the gastric irritation causes to be secreted is not swallowed, it acquires qualities which render it unpleasant to the sense of taste, and we are forced to reject it. Why then may we not believe, that certain well-marked shades of gastric and pharyngeal derangements can render it sufficiently irritating to pro-

duce, by its inoculation upon another person, the phenomena of hydrophobia.

The saliva has all the qualities necessary to serve for the solution of aliments; it is alkaline and soapy, which renders it miscible with greasy substances; it is watery and mucilaginous for those which only require water and mucus to be divided and held in a state of solution: but whenever inflammation of the mucous surface of the stomach has deranged the mode of action of the secretors, it ceases to be calculated to fulfil these purposes; and the most certain index of this is the unpleasant impression it makes upon the taste.

Section X.—*Of the Physiological Action of the Liver.*

We have recognised in the liver two functions. The first, that is to say the one first exercised, relates to the circulation; the second is that of the secretion of bile. It is probable that the blood conveyed by the vena portarum is not foreign to the formation of the bile, since it is confounded with that of the hepatic artery in the parenchyma of the liver; but to say with the older writers that the bile cannot be formed but by venous blood, is, in our opinion, to advance too bold a position, since the hepatic artery sends branches to each of the glandular acini that compose the liver.

The secretion of bile is an uninterrupted process, and a portion of that humour, after having traversed the hepatic canal to even beyond its middle, flows back into the gall-bladder.

Arrived in this vesicle, the bile remains and undergoes a concentration attributed to the absorption of a part of the serum, albumen, and mucus that it contains. This concentrative absorption is analogous to that observed in all the reservoirs which receive the product of secretion. The cystic bile is then stronger than that which comes immediately from the liver, so that the name of *gall* has been applied to it, and serves to distinguish it from the former. The stimulation of the digestive passages greatly augments the formation of bile, and, moreover, determines its evacuation from the gall-bladder. This double influence takes place by the irritation of the mucous lining of the digestive organs being propagated to that which lines the interior of the biliary canals. We have already observed that the bile was attracted to that portion of the digestive canal where irritation existed; and hence we are led to believe, that the internal surface of the duodenum is not the only part of the mucous membrane which solicits the secretion and excretion of

bile. Thus, whatever be the point irritated in the whole extent of the digestive canal, the irritation spreads over all the remainder, penetrates into the liver and gall-bladder, and produces the effect above indicated.

Formerly the emptying of the gall-bladder was attributed to the pressure exercised upon it by the stomach; but this mode, altogether mechanical, cannot now be admitted. We must conceive the proper tunic of the gall-bladder to be contractile, and imagine it obeying the stimulation of its mucous membrane. The same effect must take place in each glandular acinus of the liver, which receives the stimulation propagated along the excretory canals. The blood must then flow in a great quantity into the parenchyma, in order that the bile which is evacuated be replaced by a fresh portion; whence it results that the more the digestive canal is stimulated, the more abundant does the secretion of bile become.

We must always establish a difference in the action of stimulants. All rubefacients, (as they may here be called,) such as bitters, acid or saponaceous substances, &c. augment the biliary secretion; it is the same case with those medicines which solicit the contraction of the canal and provoke evacuations, whether by vomiting or by stool; but those which are astringent, and constrict the vascular system, by producing a permanent contraction, arrest to a certain degree this secretion, diminishing at the same time that of the mucus, and retard the peristaltic and anti-peristaltic movements of the muscular tunic.

In general, a stronger and more frequently repeated stimulation is required in order to excite the gall-bladder to evacuate its contents. It is thought, in consequence, that the irritation of the duodenum is the most efficacious, and that, in ordinary digestion, it is at the moment when the chyme traverses that intestine, that the cystic bile is brought to mingle with it. Yet we may observe that it is not until after violent and repeated efforts to vomit, that this bile is cast up, which is always recognizable by its being of a deeper colour and more bitter taste than that which comes immediately from the liver.

The bile unites to the property of dissolving and assimilating chyme, that of being a very efficacious stimulant to the muscular membrane of the canal. It must then favour the progression and evacuation of the residue of digestion. The pancreas receives the stimulation in the same manner and time with the liver; and its

fluid, which is compared to that of the salivary glands, concurs to render perfect the assimilation of the chymous matter.

Section XI.—*In what manner the Secretions become Causes of Disease.*

The sebaceous follicles, excited by the stimulation of the skin, contract an irritation which converts them into so many seats of phlegmasia. The irritation is at first often general in the skin, and truly sanguine; afterwards, the erysipelas becoming appeased, the irritation persists only in the follicles, which furnish an excretion convertible into scabs. At other times, the disease ends in light reddish pustules, running more or less into each other, crowned at top by a vesicle which bursts, and the subjacent humour discharging itself, takes on also the scabby form.

When once the irritation is established in the sebaceous follicles, it persists, in common with all others, by an organic habit, and spreads itself into the different regions of the skin. This is what is generally known under the name of *herpes*, *tinea*, &c. kinds of sub-inflammations which vary according to the temperament, the degree of irritation, the region of the skin affected, and the shade of the phlegmasia or sanguine inflammation in combination with it, but which are all essentially of the same nature.

Sometimes these sub-inflammations are the consequence of irritation in the mucous follicles of the genital organs, and then they are termed *syphilitic*. They are more especially attributed to the introduction of a virus following inoculation of these organs: but genital phlegmasiæ are so often presented under the sole influence of irritation, as for example, in the coition of two healthy persons, the consequences of masturbation, &c. that it is difficult to admit the necessary existence of a special poison to provoke them, and that, consequently, the cutaneous affection which follows, cannot be considered as dependent on that cause. The cutaneous scabby affections have, from the most remote antiquity, been attributed to virus; but herpes and tinea have been exempted from such causes, and referred to an inflammatory irritation. The only ones any longer considered virulent, are the pustules consecutive to the phlegmasiæ of the sexual organs, and there already exists among physicians a numerous party who, even in all these cases, can see nothing but irritation.

It has been well ascertained that all the diseases of the sebaceous follicles, which I rank as sub-inflammations, are more common and more tenacious in certain subjects, than in others; which supposes an innate predisposition of these follicles to irritation. Now, this predisposition coincides with that in the cryptæ mucosæ, the lymphatic ganglions, and the tissues in general, which are destined to the white fluids, or lymphatic part of our humours; hence have we described all these irritations collectively under the title of sub-inflammations.

The mucous follicles, or cryptæ mucosæ, are, more rarely than the sebaceous, irritated independently of the membrane to which they belong; most commonly it is that membrane which contracts irritation under the influence of stimulating causes, and the mucous glands which pervade it furnish a morbid secretion, called *mucosity*. Indeed, this humour ceases to have the characteristics of simple mucus: it is mucoso-albuminous, and very often presents all the appearances of phlegmonous pus; at other times it concretes, forming membranous productions. Finally, there are cases in which the inflammation appears to have subsided in the membrane, and to persist only in the follicles under consideration, which furnish a very abundant mucosity, and are converted into supplementary depurators of the skin and the kidneys.

It is very rare that irritation is thus circumscribed in the mucous follicles. It is more common to see it harden the mucous membranes and their follicles, afterwards to soften the whole, and to convert it into a suppurating surface which is dissolved and destroyed, and occasions a loss of substance in the whole thickness of the mucous membrane. Of this nature are aphthæ, chancres, and the affections called chancrous, which are observed upon external as well as internal mucous membranes. In truth, the name of chancre is only applicable to ulcerations of the openings of the mucous membrane; but let us be told wherein do they differ from those ulcerations which corrode the interior of the trachea, of the bronchiæ, of the bladder, and of the mucous lining of the digestive organs? Doubtless the difference can only be in their seat: we every where see the cellular tissue swell and harden, when the ulceration is chronic. Such is the origin of scirrhus, which, like the ulcerations in question, should be referred to the series of sub-inflammations,—always bearing in mind that, in most cases, it commences by an acute sanguine inflammation, more or less diffused, which, in a more advanced stage, losing its intensity, becomes

chronic, and is finally reduced to a sub-inflammation of varying extent. Thus, sub-inflammation succeeds to phlegmasia in the mucous membranes as well as in the skin; but that does not prevent the former at times partially developing itself, by a small pustule upon the surface of the mucous membranes, as is observed upon that of the skin.

Keeping in view the causes which call into play the action of the follicles secreting mucus, we shall conceive how their morbid irritation must occasionally succeed the stimulation of foreign bodies, placed in contact with the mucous membranes, and at other times to the influence sympathetically exercised by another organ upon these tissues. From this it is seen that the mucous sub-inflammations will sometimes result from the cessation of the perspiratory action of the skin, and that, in other cases, it will come on consecutively to the irritation of another mucous membrane. It is thus that the mucous lining of the lungs or mouth, is affected by the irritation of that of the stomach; the covering of the glans penis by that of the bladder or vesiculæ seminales; and the mucous tissue of the velum palati and tonsils consecutively to that of the sexual organs. The supposition of the existence of virus being essential to the developement of sub-inflammations is then altogether gratuitous. It is, however, important to enter into an explanation of this subject: if by virus is understood a matter applied to the surface of a mucous membrane, it certainly is impossible to deny the irritating influence of such a cause. It is thus that, in the connexion of the sexes, and all direct applications of the same nature, an acrid and sanious suppuration, the effect of an acute inflammation, will inflame, excoriate, and ulcerate the mucous surface with which it is in direct contact. But all irritating corpuscules produce the same effect: the concentrated acids, saline substances, corrosive poisons, and the acrid juices of vegetables, inflame and ulcerate the mucous membranes by carrying the irritation into their follicles and entire tissue without exception; but when, as a consequence of this primitive affection, we see another developed in a mucous membrane at a greater or less distance, it is not necessary with many authors to admit, for the production of this last, the absorption of a virus taken up in the first stage of the disease, and deposited by the circulation in the second. Sympathy, or the simple vital influence of an inflamed mucous membrane, is perfectly sufficient to explain this transmission. Why, indeed, should we admit it in certain cases and not in others, since they are precisely analogous? For

example, when aphthæ in the mouth is produced as an effect of gastritis, is it attributed to a virus? When that disease occasions irritation in the bronchiæ, which ulcerate and produce phthisis pulmonalis, do we then speak of virus? The kind of phthisis that I have noticed in the *Histoire des Phlegmasies* has since then been described by the English, who have never had an idea of attributing it to a virus circulating in the blood-vessels. In those persons who have an affection of the liver, the skin often becomes herpetic; but no one attributes these herpes, which are termed hepatic, to a virus proceeding from the liver. I regard them as a repetition, not of the irritation of that viscus, but of one which exists in the mucous lining of the digestive organs, and this is a fact which appears to me to be analogous to the preceding. Now, if the existence of a virus circulating in the humours is not insisted on for the production of these mucous or cutaneous sub-inflammations, we cannot see, with the same authors, why we should be forced to admit one for the repetition of the irritation of the sexual organs in the mouth, and different regions of the skin.

But, as others allege, how many suppositions equally gratuitous will not the admission of such a virus exact! It must be asserted that it has an affinity only for a particular tissue in order to explain why it does not affect the cerebral substance, and why it is not propagated and multiplied in the cellular and serous tissues, which are at the same time very sanguineous and lymphatic. It is further necessary to explain how it is that we do not find it in the analysis of the blood, and other circulating humours.

It may perhaps be objected, that it sometimes attacks the mucous membranes of the bronchiæ and digestive organs. I would answer, in always taking part with the disbelievers in the virus, that, in a great number of cases, the inflammations and sub-inflammations of the skin are repeated in those organs without our once having a thought of referring them to a virus; such again, are herpes, which no one ever dreams of attributing to this cause. Besides, ought we not to bear in mind the irritation that has been provoked in these organs by the antivenereal medicines, when syphilis is followed by internal affections? and when this determining cause shall not have acted, will it not suffice here, as in herpes, for an inveterate external sub-inflammation to explain the propagation of disease to the internal mucous membranes?

The strongest objection perhaps is that drawn from the consecutive irritation of the periosteum and osseous system. But, alas!

rheumatism, which no one now thinks of attributing to virus, every moment produces the same effects; it gives rise to exostoses, and acute pains in the bones; and if we were unprejudiced by the idea that these affections always suppose the existence of a venereal virus, most of those cases considered as indubitable proofs of syphilis would be attributed to phlegmasia. Besides, are we well acquainted with the sympathies of the sexual organs and skin with the bones? and can we not in a great measure find in them the reasons of the propagation in question? Do we not know that the irritations of the genital organs act strongly upon the locomotive apparatus?

Finally, the last objection that can be raised in favour of the syphilitic virus, is the pretended necessity of mercury for its destruction; but if we consider, 1st, that mercury does not always cure; 2d, that other stimulants as well as it, produce cures; 3d, that we often perfectly cure by antiphlogistics, in cases where it appeared most indicated; 4th, that mercury likewise cures other irritations, we shall be forced to admit that the success of this medicine, in the affections called syphilitic, is the effect of a true revulsion. If, then, by this means we apply the doctrine which directs practitioners in the administration of other modifiers of the same order, (the revulsives,) we shall be able to distinguish the cases where the antiphlogistic treatment deserves the preference over the mercurial, and we shall cease to administer it in those cases where its employment may be prejudicial.

Such are the arguments that might be employed by the adversaries of a venereal virus. Hence it would result, that if a virus is insisted on in the syphilitic affections produced by contact of the ulcers of the genital organs, it must be granted that the irritating pus which produces them, by a true contagion, can act only locally, that it cannot be absorbed, that it will not circulate in the blood to deposit elsewhere the germ of the disease, and that, if other irritations are manifested in different regions, they will be the effect of an influence purely sympathetic, exercised by the part primitively affected. Such is the species of contagion that I have admitted in many parts of my writings, always however pointing out how difficult it is to prove the general infection and corruption of the blood, which constitutes the principle dearest to the partisans of a syphilitic virus. Nevertheless, this kind of contagion, if admitted, will never prevent the phlegmasiæ termed syphilitic, from being likewise produced without inoculations, and by the simple effect of frictions too often

repeated upon the sexual organs; which would go to prove, that irritation, whatever be its origin, can cause them.

I would here terminate the discussion of this most interesting subject, but there is one idea of which the partisans of virus would take advantage for the support of their opinion: if the lively irritation of the secretory organs, they would say, can convert their products into an irritating poison, transmissible by absorption, as we have reason to believe takes place in hydrophobia, when it is the effect of anger, why should not the mucous membranes of the sexual organs, over irritated by frictions too often repeated in the venereal orgasm, contract a mode of irritation, the excretion from which should be capable of producing the same affection in those who would be submitted to its inoculation, through the pores of the mucous membrane, even without the long-continued friction; and why should not this poison, the creation of which would thus be continually kept up, be absorbed, and develope in other places a particular mode of irritation? We do not, it is true, find it in the circulating humours; but do we meet with them in that of hydrophobia, which is here taken as the point of comparison? Besides, there are several viruses which can circulate in the humours without being perceived. The miasmata of the plague, yellow fever, all typhous fevers, variola and measles, can no more be detected by the chemist than that of hydrophobia, and yet no one hesitates to admit them. They are manifested by their effects, which are identical in their nature. This is all that we can know of them; and if to these notions we join that of the most successful means of attacking them, must it not then be admitted that there exists a syphilitic virus having its particular specific remedy?

I certainly would not venture to deny the possibility of an exaltation of action in the sexual organs, capable of creating a product very irritating to the mucous membrane, when inoculated by it. I might perhaps admit that this product absorbed, would be susceptible of carrying the irritation to other parts; but it is not the less proved, that very often some of the grades of the irritation which result from it, can be perfectly destroyed by antiphlogistics; that in others revulsives present more advantage; and, finally, that mercury is of the number of those which oftenest succeed. But the facts in the sequel will perhaps enable us to throw greater light upon this question, which I abandon, to continue the exposition of the diseases of the secretory organs.

We have seen by what causes the secretion of the tears can be

excited. When that secretion is carried too far, we find phlegmasiæ supervening, of which some are peculiar to the lachrymal glands, and others to the portion of mucous membrane which partakes of their irritation; for the glands cannot be affected alone in cases of this kind. The eyes become red, the retina engorged, the sight diminished, and all the chronic phlegmasiæ of the orbit of the eye, not excepting cataract, are apt to make their attack. The conjunctiva contracts, together with the lachrymal sac and nasal canal, a state of habitual congestion which narrows the lachrymal passages and produces fistula. The gland itself tumifies, and becomes so irritable, that the slightest stimulation is sufficient to produce a flow of tears. We may readily imagine what might be the consequence of this permanent state of irritation. There often results from it the total loss of sight, and even that of the organ which is its instrument. For the other effects of the depressing passions, we refer to what has been said in the history of the functions of relation.

Onions we know exhale a gas which is very irritating to the conjunctiva and lachrymal gland. If persons who are exposed to the handling of these roots, do not become accustomed to them, there may ensue chronic phlegmasiæ, similar to those which we have just indicated. The same effects result from smoke, and from all the causes which exercise a special irritation over the ocular apparatus, and particularly on the lachrymal secretion.

We rarely see salivation, produced by irritation of the mucous membrane of the mouth, end in an inflammation of the parotids and other salivary glands; yet this termination is not impossible. A considerable tumefaction is indeed observable about the lower maxilla, during the course of a mercurial salivation; but the state of the glands under these circumstances has not been sufficiently observed to enable us to determine whether or not they undergo a disorganizing phlegmasia. We know that they are irritated; that is the principal point; and hence we can conclude, that if any accidental stimulation should supervene, for example that of cold acting upon the surface of the skin covering the gland, they would be able to contract a very acute inflammation.

All physicians know that the parotid glands often become phlegmonous, as a consequence of the gastro-enteritis which have not been attacked at their commencement by a sufficiently powerful antiphlogistic treatment. The mucous membrane of the pharynx and mouth being always first irritated in these cases, as well as in those

in which the parotids are not affected, we think that the inflammatory stimulus reaches them by the propogation of the irritation of the membrane lining the mouth; indeed, we have seen, that during the attack of gastritis, the salivary humour was always depraved, which supposes that the organs that furnish it are irritated. We must not then be astonished that this irritation should sometimes go on even to the point of inflammation. As I have already mentioned the part performed by the irritation of the salivary glands in the phenomena of hydrophobia, I think it useless to repeat it.

The salivary ducts are susceptible of contracting particular inflammations. Their orifices may be obliterated in consequence of phlegmasiæ of the internal membrane of the mouth, which sometimes produces very considerable tumours. Thus we see cases where the decomposed saliva furnishes concretions which obliterate the excretory canals. It has not yet been determined, and there is nothing more difficult to ascertain, in what this disposition of the glands to secrete a saliva susceptible of furnishing concretions consists: the irritation of the stomach, and that of the mouth, may without doubt in some measure contribute to it, but observation has not sufficiently cleared up this difficulty.

There are cases where the secretion of saliva becomes so easy, from having been excited by phlegmasiæ of the mouth, that the slightest suppression of perspiration produces very inconvenient salivation. In these instances, the glands which furnish it have become vicarious to the depurative organs. This irritation should be placed in the number of sub-inflammations. It is the same case with those habitual salivations which return periodically at certain hours of the day, especially at that of rising. It would be necessary to examine often the condition of the salivary glands in those who have been subject to this inconvenience, in order to ascertain if they present any traces of phlegmasiæ or sub-inflammations.

The secretion of the liver, when regarded as the cause of disease merits a particular attention. We are aware of the importance attached to it by physicians, in this respect, during the reign of the humoral theories; and it is known that ontologists, in all their variations of language, are far from having made any change in the fundamental ideas of their predecessors. We are indeed no longer told of cacocholia or corruption of the bile; but we have gastric derangement, in which the bile furnishes the principal indications. It is no longer said that this fluid is thrown upon such or such parts of the body; but we are advised to treat the gastric derangement,

to which the affections of these parts are made subordinate, by medicines that evacuate the bilious humour. Although bile be not so powerful a cause of diseases as has been believed, it must however be admitted that it can give rise to some. We shall discover them while examining into the manner in which the biliary secretion may produce a pathological condition.

We will first repeat that the secretory action of the liver, although essentially continual, augments or diminishes according to the degree of stimulation of the alimentary canal, and we will endeavour to ascertain how these changes are converted into causes of disease.

Called to the stomach, in gastric irritations suddenly developed, the bile there causes an unpleasant sensation which is extended into the mouth, where its character is recognized by the taste, and provokes nausea or even vomiting. The more the sensibility of the internal membrane of the stomach is exalted, the more considerable is the sympathetic disturbance which results from the presence of bile: we may then affirm that this humour is increased by the pathological condition of the stomach; but this remark should be understood especially of the cystic bile, which is incomparably more stimulating than the hepatic.

When the irritation occupies the small intestine, the bile no longer flows back into the stomach ; it accumulates in the phlogosed points along the intestines, as is shown by post mortem examinations ; but the symptoms dependent on it are not sufficiently distinguished from those which proceed from phlegmasia properly so called, to enable us to indicate them with precision. We have only the yellow colour of the lingual mucous covering, the yellowish tinge of the skin, and the bilious odour, to guide us in the diagnosis; and even these symptoms are very fallacious.

It is not thus in cases where the inflammation is developed in the large intestines; when the bile is poured out on them, it is always attended by the colics, tormina, and tenesmus, which accompany dysentery ; but its stimulating influence becomes still more manifest at the orifice of the rectum ; for it is very evident that the expulsion of bile produces at the anus a smarting proportioned to the thickness and concentration of that humour. This is constantly observed in dysentery, and at the conclusion of the action of drastic purgatives ; the stools are then always preceded by strong tormina, which always disappear after the passage of a thick bile, the contact of which is very irritating to the anus.

In some cases, of rare occurrence indeed, the bile caused by certain moral affections, such as anger, is so acrid at the moment of its excretion that it irritates the mouth, fauces, and orifice of the anus, —which leads to the belief that to it may be attributed the violent pains of the stomach and the tormina that precede and determine its discharge.

If we examine into the effects of bile, when secreted in excess, upon the ductus choledochus and gall-bladder we shall not obtain such satisfactory data. What are termed hepatic colics attributed to this cause, are far from being always dependent on it; they are, in most cases, nothing more than painful spasms of the pylorus and duodenum. Besides, the sensibility is not considerable enough in the biliary canals to cause sensations in them similar to those kinds of colic. The gall-bladder, being more susceptible of inflammation, may without doubt suffer from the presence of the bile, to such a degree that there results from it particular pains referred to the region occupied by it: yet these cases must be rare, for many persons show after death concretions of bile, (biliary calculi,) without ever having complained of what are called bilious colics, or any painful sensation in the right hypochondrium. It is then very difficult, not to say impossible, to determine to what extent irritation is caused by the presence of bile, in the diseases which interest the liver and its excretory apparatus. When the secretion of the liver is excited by a gastro-enteritic irritation, which produces at the same time a constriction of the duodenum, the superabundant bile, no longer finding its ordinary passage of elimination from the liver, remains in it, while at the same time that which fills the excretory canals reascends. There is then a kind of retrograde motion of this humour, which impels it towards the liver, where it is already superabundant: and the ordinary result of such a morbid condition is the absorption of the superfluity of the secretion, and the yellow colour of the skin and conjunctiva. This is what is meant by the terms jaundice or icterus. This bile, diffused through the circulation, communicates its colour to almost all the tissues except the white pulp of the encephalon, and the membranes which secrete the humours of the eye. It is directed towards the kidneys, which secrete and eliminate at least a part of it; it impregnates the mucus of the membranes of relation, the perspiration and serum deposited in the areolar tissues, and the serous membranes. It is a source of uneasiness to all the sensible parts; it stimulates more particularly the skin in a disagreeable manner, often pro-

ducing on it small pustules; it acts, in a word, as a foreign body whose presence is troublesome to the economy.

Notwithstanding all the morbid effects of the bile, properly so called, it is not from it that the greater number of diseases dependent on the vicious secretion of the liver proceed: the most common and most violent have for their cause the organic process which furnishes it. Indeed, this process when too exalted is converted into an acute or chronic inflammation, which, if not arrested, destroys the organization of the liver. This is manifested, in the acute state, by the phlegmonous inflammations, which are converted into an abscess, and in the chronic by a painful tumefaction, which produces the enlarged condition and other hepatic degenerations that we so often meet with in persons who have long suffered from chronic gastritis and enteritis. Post mortem examinations have indeed apprized us that these kinds of degeneration correspond particularly with the inflammation of the stomach, small intestines, and especially the duodenum; and since experience has taught us that in removing these phlegmasiæ we cure the hepatic affections, whilst they are exasperated by purgatives, it becomes evident, for every man who wishes to reason, that the disease here proceeds from irritation of the digestive canal, communicated to the parenchyma of the liver, and not from the influence of what is properly called bile. I constantly find that whatever be the intensity of the phenomena attributed to bile, and the alteration and acrimony of that humour, calmness is re-established so soon as a cessation of the gastro-enteritis is effected; and the bile resumes its ordinary course, ceasing to be an irritant in the interior of the digestive canal. The indications furnished by the bile as a foreign body necessitating the use of evacuants, are, however, not always illusory; but they should be restricted to a small number of cases, the pointing out of which I will dispense with here, since they are in the cognizance of pathology.

It has been thought that when the secretors are in extraordinary action, there is a number of organic movements directed towards their tissues, and that they thus become the point to which the efforts of the vital powers are directed. This theory is inexact. The secretors, as has been observed by Bichat, are obedient to the stimulation of the membrane of relation, upon which is deposited the product of their organic actions. When they receive too lively a stimulation, they indeed become the centre of inflammation, but it is not because the vital power propels the fluids to-

wards them, but because they attract them; and, as soon as their vital erection is made to subside, or rather reduced to its natural state, the fluxion ceases, which would not happen if the intention of the vital principle was to engorge them. In admitting this mechanism, it is not necessary that it should act upon the irritated secretors, but rather upon the vital principle itself. But where does this principle reside, and what are the means of which we are possessed for correcting the derangements under which we suppose it to labour? The seat that may, with most reason, be assigned to it, is, without doubt, the brain. It would be then necessary, in the super-secretions of the liver, for example, to address our remedies to the brain, in order to cure bilious diseases. But, except these cases where it is itself in a state of phlegmasia, this practice would have no effect. It is, therefore, to the secretors themselves and generally to the neighbouring mucous surfaces, that we should address the means calculated to moderate the secretions; and these means ought generally to be selected, not from the evacuants, but rather from the antiphlogistics.

The secretion of the pancreatic juice is obedient to the stimulations which act upon that of the bile. It is certain that inflammation of the pancreas is less common than that of the liver; and we have no distinct idea of the disorders which may correspond either to the superabundance and alteration of the pancreatic juice, or to the irritation of the gland itself, except the inflammation has attained the degree which corresponds to the phlegmonous. The fluid of the pancreas is susceptible, like all the other products of the secretors of being decomposed, and of forming concretions, which are seen in its parenchyma or obliterate its canals; but upon this point semeiology is not less obscure than in those of the diminution and augmentation of the secretory action of this gland: the painful tumefactions of the lower region of the epigastrium may depend on so many different tissues, that, according to all appearance, it will be, for a long time, difficult to raise the veil by which the real affections of the pancreas are obscured.

We may say of the liver and of the pancreas, what we have said of perspiration and the tears: lively irritations of the animal economy, and that excitation of the heart which constitutes the fundamental phenomenon of the febrile condition, sometimes terminate by abundant evacuations of the digestive canal, of which these glands furnish the principal materials. Such kinds of eva-

cuations likewise dissipate the super-irritations of the alimentary canal, produced by emetics and purgatives; for whenever these medicines do not occasion a bilious or mucous super-secretion, they create gastritis or enteritis; it is then a general rule, that all irritations have a tendency to terminate by the elimination of fluids. The secretors of bile and of the pancreatic juice can, like all those which we have examined, contract a habit of action which renders them, to a certain degree, supplementary to the ordinary depurators: and when they have for a long time fulfilled this function, they are altered, and the glands experience a degeneration, which, when it does not extend to the formation of purulent collections, can only be referred to sub-inflammations.

When the action of a secretor, for instance that of the liver, has for a long time been excited in a moderate degree, and has produced a tumefaction with stagnation of the blood, and fluids secreted in their respective cavities, art sometimes succeeds in dissipating this engorgement, by exciting suddenly, and in a more energetic manner, the secretory action; but this method, too often repeated, never fails to augment the disease of which it is thought to be the remedy; we may then rank it among the most powerful causes of the affections of the secretory system.

Such are the different ways in which the secretory functions may act in the production of diseases; they concur to prove that all the vital excretions which are raised above the natural type, tend to inflammation or sub-inflammation, and produce neuroses, by reacting upon the nervous apparatus, the sole conductor of stimulations developed in any point whatever of the living animal economy.

CHAPTER X.

OF THE INTERNAL EXHALATIONS.

THERE are many thousand outlets to the fluids which circulate in the vascular apparatus. We have just examined the principal ones; those which give issue to the superfluous fluids, and those which permit the humours destined to the performance of certain functions, to pass out, after being fashioned in a particular manner. There are others more numerous still, which favour the extravasation of a part

of the mobile animal matter, and place it as a deposit, for some time, upon surfaces of greater or less extent, whence it enters into the circulatory current.

When we reflect on those numerous outlets which present themselves in the round of the circulating fluids, we have reason to be astonished how there can remain sufficient blood in the vascular apparatus to furnish nutriment to all the tissues. We ask by what power it is that this fluid is retained in its vessels, and we find it to be none other than the elective affinity which draws certain molecules of mobile animal matter towards other molecules of fixed matter; that is to say, this internal chemistry wholly submitted to the vital power which constitutes the fundamental phenomenon of the organic functions. Those who have been opposed to the expression vital chemistry, have alleged no other reason, except that this chemistry is not subservient to the same laws with that of inert bodies. But has this difference ever been contested with them? Is it not rather upon this that I have established the characteristics of the chemistry of organic bodies? Have I not repeated to them that it was under the direction of the power presiding over life, and that it could have nothing in common with the chemistry of unorganized bodies, except the changes of composition, and transformations of matter founded upon the play of molecular affinities. This, then, is what constitutes this kind of chemistry. Is there any thing more clear? or is it the word chemistry which is so displeasing to our opponents? But is this word, then, only applicable to the molecular affinities of inert bodies? They wish those of living bodies to be designated by the term vital phenomena: but this is not sufficient to distinguish them; it confounds them with the exercise of contractility, with sensibility, and with all the prodigies of the intellect, which are, as well as that chemistry, phenomena appertaining to life. If those gentlemen reject the term vital chemistry, what will they adopt in its place, in the state in which the nicety of our distinctions upon physiological phenomena place the science? Circumlocutions alone will be left them. It will then every instant be necessary, in order to designate the phenomena to which we consecrate the word employed, to use some of the following:—*vital molecular affinities; vital compositions and decompositions; vital appropriation of mobile molecules by fixed molecules; vital disorganizations and decompositions of the tissues*, etc. etc.: but these different modes of expression would seem to designate facts altogether different, whilst they in truth

mean the same thing, diversified by causes which we are unable to specify. Would it not be better to express these facts by a single term? and does not that of vital chemistry present itself as the only one suitable? Indeed I cannot conceive why persons are thus opposed to the perfecting of language, as imperiously demanded by the progress of the science. They assume an imposing and dictatorial air, in order to tell us that the vital transformations do not resemble those in the crucibles of our chemists. They would appear to teach us this difference, whilst it is upon it that we rest for the adoption of the term vital chemistry: but it would be in vain, —it will ever be impossible to dispense with it, in our efforts to establish a classification of physiological phenomena, without the risk of diffuseness of language, and throwing the subject into confusion and obscurity. Invent another word,—it is to me immaterial: take it from the Greek, though the Greeks knew nothing of chemistry; still it must always express the same fact, the play of the molecular affinities, under the influence of life: or, if you do not wish to distinguish life from matter, it consists in a play of molecular affinities, making part of the phenomena which distinguish living bodies. All these petty cavils do but little honour to these gentlemen, for they only announce their superficial views, and a want of attention in reading new works, even though they should not proceed from less excusable motives. The term vital chemistry is not of my own invention, but I have adopted it from Fourcroy, by whom I have often heard it used, as necessary to the distinctions I am forced to establish between the organic phenomena, which the celebrated Bichat has considered in such a summary manner that they are still involved in much obscurity. When the futility of these distinctions shall be demonstrated, I will abandon the term vital chemistry; until then, I will continue to employ it, and I now proceed to use it for elucidating the phenomena of what is designated under the head of internal exhalations.

Section I.—*Of the Tissues charged with the Internal Exhalations.*

There tissues are very numerous: among the first is ranked the areolar, which is always moistened by a lymphatic vapour, and a peculiar cellular tissue which exhales an animal oil, termed in some parts the *fat*, and in others the *medulla*. These tissues are not limited to the superficies of the body, interstices of the muscles,

and spaces left between the many contiguous viscera: they insinuate themselves between the fasciculi of the muscle itself, immediately envelope certain viscera, as the heart, surround the vessels, to which they furnish a sheath, and with them are insinuated into the different parenchymæ, and even penetrate into the interior of the bones.

If we examine the celluloareolar tissue in the different organs, we shall find that in certain regions it is filled with fat, whilst in many others it is only moistened by a lymphatic vapour; in general, whenever the fat might prove injurious, either by exercising too great a compression, or in giving to the part an increased volume, or finally, by opposing the necessary evolution of caloric, this substance does not exist; whilst the lymphatic vapour, which is essentially necessary to facilitate motion, is every where met with.

In the bones we observe two kinds of oily humour: the central cavities of the long and cylindrical bones are lined by a cellular membrane, which furnishes what is called the medulla; the flat bones have, in the intervals which separate their two plates, an osseous areolar tissue called *diploe*, which contains a membrane exhaling an animal oil more fluid than the medulla properly so called. These membranes communicate with the general cellular tissue by that which accompanies the vessels distributed to them, after having pierced the external osseous stratum, always more condensed and harder than the internal laminæ.

The fat likewise varies in density in the cellular net-work interposed between the organs; it is more concentrated about the kidneys, and in the sub-cutaneous cellular tissue, but is found of less consistence between the coats of those viscera that are supplied with it.

Next to the lymphatic and unctuous cellular tissues, we have the membranes called by Bichat *serous*. They have, we know, been compared by him to sacs without apertures, the internal surface corresponding to itself, and the external being adherent to the surrounding parts, by means of cellular filaments. On the same line with those membranes appertaining to the great viscera, such as the brain, lungs, heart, and the abdominal cavity, are classed the synovial and tendinous capsules, whose free surfaces are likewise in relation with themselves; and the external which correspond to cartilages, ligaments, or tendons, are united to these latter by a very strong and compact cellular tissue. The vapour which moistens the first is called *serum* or *serosity;* that furnishing the second is called *synovia*. These two humours, formed however of

indentical elements, differ as well as the fatty ones in their degree of concentration, the serosity being always more watery, and the synovia more lymphatic and albuminous; as to the areolar tissue by which the membranes adhere to the parts covered by them, we find in it either lymph or fat according to the wants of the organs. It is thus that the exterior of the epiploon and the mediastinum corresponds to an abundant adipose tissue, whilst the cellular filaments by which the peritoneum adheres to the anterior portion of the intestines, uterus, liver, and the greater part of the spleen, only contain general lymphatic vapour. There is the same arrangement in the pleuras, which have no fat behind them except at the mediastinum, and in the serous membrane of the pericardium, which only presents some at the service of the heart, but does not offer any between it and the pericardiac sac, &c. The arachnoid is the only serous membrane the external surface of which never generates adipose matter. Fat is never admitted into the cranial cavity, and the reason is too evident to require its annunciation: as to the synovial membranes, their external surface never corresponds to fatty matter, except when it is no longer in application with the articular cartilages, and fibrous membranes called *lateral ligaments*, &c.; but there are met with certain free spaces between these latter, as we see in the popliteal regions, which are filled with a tolerably large quantity of fatty cellular tissue.

Such are the principal tissues on which the internal exhalations are performed. We must place on the next line some membranes which their resemblance, as respects exhalations, has led to be approximated to the preceding ones: such in the first place are those that secrete the humours of the eye, and the membrane furnishing the lymphatic humour in which is bathed the portio mollis of the auditory nerve.

SECTION II.—*Of the Physiological Action and Uses of the Serous, Adipose, and Medullary Tissues.*

All these tissues are to appearance of a very simple organization. Notwithstanding which, the sanguineous capillary system, some lymphatic vessels and nervous extremities are lost in them, and seem to constitute, in conjunction with the cellular laminæ, a homogeneous tissue, the dissection of which is impossible; but this form of fixed animal matter performs certain functions which we have it in our power to notice. It furnishes humours which are

deposited in its interstices, and which remain there for a certain time. Many hypotheses have been advanced respecting the manner in which these humours are formed: some have thought they were merely separated from the blood, that is to say, secreted by collateral vessels: others, modifying this explanation, have pretended that there are no peculiar canals charged with the office of selecting them from the blood in virtue of an elective sensibility, but that they were merely exuded by the porosities and perforations of the arterial capillaries.

We may readily suppose that explanations have been carried too far. Indeed, the collateral and excretory vessels cannot be demonstrated in the tissues, in which we are unable even to perceive the termination of the sanguineous capillaries of the lymphatics or nerves. It was useless then to descant on the mode of vitality of these pretended collateral vessels, or on the perforations and porosities of the arterial ones. Besides, how can we explain by a simple transudation through the arteries, the formation of humours which moisten the areolæ of the laminated or serous tissue, when we find such notable differences among these fluids? Does not the serosity of the arachnoid differ from that of the pleura, and this latter from the vapour of the peritoneum? Can we compare any of these humours to those of the articular and tendinous capsules? Are not the latter incomparably more dense and resisting, as being destined to moderate the effects of a much more considerable pressure? The synovia ought to be composed of rounded globules of extreme tenacity, and intended to roll between the smooth surfaces which clothe the articular cartilages, in order to prevent their immediate contact, which would produce laceration and inflammation; but would not such globules be hurtful between the free surfaces of the arachnoid, where the pressure is incomparably less strong; and reciprocally, of what avail would be a vapour of such tenuity as that of the arachnoid between the cartilages and tendons? Each serous and synovial surface being subjected to very different degrees of pressure, it was necessary that the composition of the humours should be adapted to this pressure. There is then between the serous, synovial, and capsular membranes differences of organization which we cannot explain, but of which we are allowed to have a conception by means of reasoning, and on which depend those of the interposed humours. Hence the explanation by which the formation of these fluids is attributed to

simple arterial porosities falls of itself, and requires no other kind of refutation.

It is still more difficult to explain by such a mechanism the production of fatty and oily humours, for they do not exist in the blood: we are then compelled to allow that the cells, which contain these kind of humours, fabricate them immediately at the expense of the fluids in circulation; and since dissection cannot show us organized ducts in the form of vessels which may be intrusted with bringing about this transformation, we are compelled to refer it to an inexplicable kind of organic action residing in the walls of the adipose cells, and which, as well as the formation of serous and synovial fluids, can only be considered as purely a phenomenon of vital chemistry. In fact, even though we should refer these combinations to the movements of contractility, it would always be incumbent on us to explain how the alternate condensation and relaxation of living fibre can bring about combinations which had no existence in the circulating fluids. All that can be said, in setting out from these data, is, that the movements of contractility in fixed animal matter agitate the fluids, propel them in directions determined by that of the vessels, force them to delay in certain parts, and, finally, conduct to the same place, and put in relation with them, certain fluids already different in their nature from each other. To this, in fact, is reduced the part of contractility; but whilst it gives motion to or retains the fluids, chemical affinities are in action, which change the combinations of the circulating molecules, by drawing some of them towards the fixed animal matter, whence results nutrition; and by detaching others from this lattter to restore them to the mobile animal matter, which constitutes decomposition; finally, by producing, at the expense of this mobile animal matter, fluids more or less differing from blood, which gives the secretions, and forms thereby the different serous or synovial fluids, which we would in vain attribute to the too simple mechanism of exhalation.

Internal exhalation and secretion are then nothing more than two general varieties of a phenomenon fundamentally the same, that is to say, the operations of vital chemistry, the specific differences of which elude our view. Now all these being applicable to the formation of the humours of the eye, and that of the fluid in which the acoustic nerve is immersed, I believe that it would be very useless to be detained with them.

Generally speaking, there is an agreement of opinion on the uses of the fluids deposited in the tissues which have just been examined. The serosity of the laminated tissues and serous membranes can answer no other purpose but that of giving suppleness to the different organs, and of facilitating their movements of condensation, expansion, and separation. As it must be absorbed in a proportion corresponding to its exhalation, it cannot contain any thing heterogeneous to the most healthy and nutritive humours; and of course it is not stimulating in its normal state. The mechanism by which it is made to enter into the circulating current is analogous to that of its formation; since we must suppose a play of molecular affinities between this humour and the porosities by which its suction is accomplished. Vainly will it be attempted to weaken this proposition by alleging the absorption of a number of liquids foreign to the animal economy. I would reply, that these latter are often united by affinities with living matter. This question will receive developement when we treat of general absorption.

The uses of the adipose matter are more numerous than those of the serous and synovial humours. It has in the first place, in common with these latter, the office of faciltiating the motion of one part on another; but, in addition to this, we attribute to it the faculty of aiding in the preservation of the temperature suitable to the human body, by opposing, in its character of bad conductor, the too rapid evaporation of caloric. Experience is conclusive on this point: we know that the fat abounds around the principal organs, that it protects them all by being accumulated under the skin, that persons who are deprived of it support the cold worse than those who are abundantly supplied with it, and that these latter cannot be acclimated in arid regions without losing a great part of their fat. Finally, we have observed that the warm-blooded animals of cold countries are fatter than those which inhabit the equatorial climates.

The third use of fat is relative to nutrition. In fact, though we find none in the blood, at least during the state of perfect health, we observe that adeps is only accumulated when the wants of nutrition are gratified, and that it disappears whenever the body does not find in digestion nutritive materials sufficient for its support. But I am encroaching on this question, which ought to be brought forward in the pathology of internal exhalations.

The fat is likewise considered, and with much reason, as concurring to beauty and the voluptuous sensations attached to the ap-

proach of the two sexes; it gives, in fact, roundness to the figure, softness to the contours, and to it more especially do women owe their most winning charms. In the female sex, we find it accumulated, at the age of puberty, about the organs which are to serve for generation, and rendering them more prominent, as if to indicate the predominance of action which they have just acquired, and, also, to reveal their uses. It is to the fat that youth owes its beauty and freshness; it is the index of strength and health; it announces a fulness of life; and nature, by placing it in man around the muscles which are the best defined, makes use of it as a means of indicating their energy, and ability to support labour and privations. In general, we hold animals in estimation proportionate to the fat by which they are embellished. In a word, this matter is the ornament of animated nature, whilst the want of it inspires us with the ideas of weakness, poverty, and death.

The quantity of marrow is, generally, proportionate to that of the fat; and hence, like this latter, it abounds in a state of health, and, like it, disappears in disease. Its use is supposed to be to render the bones more flexible and more difficult to break, and to favour their consolidation after fractures. Might it not be for the bones what fat is for the soft parts, a kind of deposit of the superfluity of nutrition, destined to aid in their restoration in case of need?

The fat and marrow are, undoubtedly, continually renewed, though still this change is far from being as easy and as prompt as that of the serous vapours. The fatty humours are almost always decomposed, and lose their distinctive characters, after penetrating into the circulating current. There are, however, cases in which their properties are retained, but these are more frequently within the province of pathology.

The tissues in which the internal exhalations are performed, consist of gelatin, and enjoy contractility in a degree faintly defined, but not the less existing, since they can return upon themselves in a great number of cases. They are not in a normal state productive of any sensation.

As to the humours of the eye, their use is most evident; so also of the liquid which bathes the pulpy expansion of the acoustic nerve: they are destined to aid in the exercise of these senses, and their renewal must be much prompter than that of the oily humours.

Section III.—*In what manner the Internal Exhalations become Causes of Disease.*

The internal exhalations are brought about in a uniform manner, and do not seem to be sensibly augmented in the normal state, by the stimulations of the organs of relation, which vibrate the nervous system, and act so powerfully on the heart, and vascular and secreting systems. Were it otherwise, our frames would never have any stability. Nature has therefore so ordered it, that the tissues for exhalation should remain alien to the daily sympathies inseparable from the exercise of the functions; and it is from not having properly understood this truth, that physicians have admitted so many general diseases. When an inflammation is developed in the mucous membranes, and in the parenchymatous and secreting organs, the cellular tissue the nearest to the seat of disease participates in it, and the nature and the quantity of the fluids there exhaled undergo changes: but in the other regions these tissues are not directly affected, they only undergo increase or decrease in the quantity of their fluids, according as the circulation is performed with more or less rapidity, or as the mobile animal matter is diverted towards another organ, or evacuated in larger quantity than usual. It is in this way that an excess of exhalation takes place in all the cellular tissues adjoining the seat of the inflammation, and that those which are remote are nearly dried up. The cells containing fat are then deprived of it by absorption, and the body in general becomes thinner, whilst the parts adjoining the inflammation are hypertrophied. Generally speaking, we discover that, in this case, it is not the primitive affection of these tissues to which the disorder in the animal economy can be referred; in other words, they are not affected in a primary or idiopathic manner.

In chronic irritations of the mucous membranes, parenchymæ, and secretory glands, when the inflammation has lasted for a length of time, the nutrition of the cellular tissues surrounding them is remarkably deranged. They become swelled, and engorged with lymph and a serosity of varying thickness and deviation from its natural composition. At this time, the equilibrium between exhalation and absorption is destroyed in the analogous tissues of other parts of the body; and if the inflammation of that primitively affected be not acute, if it be not sufficiently strong to accelerate the circulation and keep up fever, if it be limited to producing an afflux of lymph,—in a word, if it do not exceed the degree of sub-inflam-

mation, the general derangement of exhalation and absorption ends in dropsy. There is, in this case, a cause of disorder proceeding from irregularity in the internal exhalations; for the accumulations of serosity are a cause of particular derangement of the functions; but, under such circumstances, we always find, that the disease of the internal exhalent tissues is but consecutive, and that the derangement in the health always commenced by an affection of other tissues.

Thus, to recapitulate, the tissues on which internal exhalations are performed, become secondary causes of disease, either by wasting, as in *marasmus*, or by acquiring, as in *hypertrophies* and dropsies, whenever irritation has been fixed for any time in the organs of relation. Let us next inquire, in what cases the exhalent tissues are primarily affected.

The most powerful and usual causes of the primitive affections of the tissues are external injuries; in fact, commotions, contusions, and wounds, affect at the very instant the cellular, serous, and medullary tissues; in them take place the lacerations and ruptures which are attended with ecchymoses and frequent phlegmons, as we see after falls, shocks of the limbs produced by fire-arms, explosions of gunpowder: to their inflammation we refer all the phlegmons of which surgeons usually take charge. The tissues of relation and the secreting organs are not, however, always exempt from irritation in such cases; but whenever they are so affected, that does not prevent the cellular tissue from suffering at the same time; and even when the former are exempt from any lesion, as always happens in the traumatic affections of the exterior of the body, the cellular tissues are still affected. It is, likewise, to the inflammations of the cellular tissue we refer that met with in all wounds; on it depend vegetations and fleshy excrescences, the growth of fungous flesh to excess, the generation of pus and the various aspects which it may present, scirrhi, and, in fine, the formation of cicatrices in which the cellular tissue is more or less condensed and altered in its organization.

It is therefore in a more peculiar manner, as we have already said, in cellular inflammation and its various modifications of phlegmon, that surgery is engaged. As, however, the phenomenon, though local, exerts powerful effects over the animal economy, and is susceptible of propagation and transmission, it often happens that cellular inflammation of wounds and contusions calls into play that of the tissues of relation, which had not been primitively inte-

rested; hence traumatic fevers, which depend on secondary inflammation of the mucous membrane of the digestive canal and brain, and which may be converted into alarming diseases; hence the convulsions which an over-irritated brain often produces; hence, likewise, the derangement of the secreting organs brought on by preceding irritations. It is thus that primary irritation of the internal exhaling tissues becomes a very potent cause of disease in the animal economy.

We must not, however, imagine that wounds can produce irritation only in the mucous and secreting tissues of the viscera. It often happens that the traumatic inflammation of the cellular tissues is transferred to the serous membranes of the same viscera; proofs of which are found in the pleurisies, pericardites, arachnites, and peritonites, which we see all of a sudden supervene on the suppuration of an external wound, and which seem to be excited by similarity of structure; for the closest connexion is observed between the cellular tissues and the serous membranes.

Next to wounds, the most frequent cause of irritation in the internal exhalent tissues, is the suppression of the secreting and depurating function of the skin. This, which gives origin to so many affections of the mucous membranes and the secreting organs annexed to them, may also exercise a direct influence on the lymphatic and adipose cells. It is by this means that cold, in retarding the action of the skin, suddenly gives origin to phlegmons, articular rheumatisms, pleurisies, and peritonites. Sometimes, indeed, the first irritation, supplementary and abnormal, which succeeds to the impression of cold, is manifested on the mucous tissues and secreting glands, which it traverses in order afterwards to be fixed on the serous membranes enveloping them, or in the cellular tissue in which they are imbedded: we have proofs of this in the catarrhs, colics, diarrhœa, and nephritic pains, which precede by some hours and even some days, pleurisies, peritonites, and phlegmonous inflammations of the kidneys. But there are other cases in which the inflammation caused by cold, is evidenced from the very commencement, in these last tissues; and when it suddenly breaks out in the articular capsules, ligaments, cellular and aponeurotic tissues, interposed between the muscles, it is impossible to say that it at first existed in the mucous membranes and secreting organs. It is therefore evident, that the cause of which we speak, the suppression of external exhalation, may bear directly on the internal exhaling tissues, and that the disturbances, which supervene in

the functions, owe their origin to the primitive irritation of these parts. It is not always acute inflammations which succeed the suppression of cutaneous depuration. In cold and temperate climates, in which the atmospherical vicissitudes are very frequent, there is often developed lardaceous and scirrhous masses, kinds of abnormal hypertrophies, and sub-inflammations, in various regions of the body. On this account the post mortem alterations of this nature are incomparably more frequent in the north than to the south. These facts prove that the internal exhalations, having become predominant, in consequence of diminished stimulation of the exterior, are converted, in the tissues intrusted with their performance, into an irritation which rouses them from the torpor in which they had been accustomed to live, and places them in connexion with the organs which transmit to them inflammation and sub-inflammation.

Suppressed cutaneous transpiration exercises likewise an irritative influence over these tissues, which follows immediately after sub-inflammation: I now allude to œdemas and dropsies of the serous membranes, which we at times observe succeeding the impression of cold; swellings of the body, impeded movements, and feeling of suffocation, which afterwards come on, as also the obstacles to the circulation and respiration, are here effects of the primary affection of the internal exhalations.

The same kind of alteration may be met with after an abundant absorption of liquids, whenever the eliminators of the superfluous serosity are not inclined to action; in such cases the internal exhalations become all of a sudden their substitutes. Do we not, in fact, meet with ascites and general œdemas which recognise no other cause than the excessive drinking of water, soups, wine, &c. which the kidneys, skin, and other outlets for depuration, have refused to eliminate.

Heat directed to a part of the body, and the vivid and local impression of intense cold, sometimes give rise in the skin to an irritation, which extends to the sub-cutaneous tissue and there becomes predominant; whence still result phlegmons.

Mental emotions do not seem to exert a direct morbid effect on the tissues for internal exhalation; but such may result by the transmission of that which the passions have given rise to in the tissues of relation.

There are cases in which the cellular tissue is predisposed in an extraordinary manner to inflammation, without its being always in

our power to give a satisfactory explanation. Depurations of matter are then multiplied after the slightest irritation, as if the adipose net-work had acquired the irritability of the membranes of relation. Inveterate gastro-enteritis seems to be often the cause of this. The puerperal state likewise produces this melancholy diathesis when mothers refuse to suckle their offspring; it seems that, in these cases, all the tissues have acquired an extraordinary inflammatory mobility, and are disposed to become, by the slightest irritation, the rendezvous of the superabundant lymphatic humours, which nature had destined for the nourishment of the child.

Whenever the muscles degenerate and their fibrin disappears, in order to make way for an albuminous or lardaceous tissue, as we often find after chronic rheumatisms, which for a length of time had prevented motion and forced the limb to absolute rest, this change is owing to a developement of the cellular tissue interposed between the muscular fasciculi. We know that this tissue penetrates between each muscle, then between the fasciculi composing it, and finally between each red fibre, as far as they can be divided, and to such an extent that the last cellular filaments are of a wonderful tenuity. Accordingly, in the diseases under consideration, the irritation is transmitted along these very delicate cellular laminæ, as well as in those which accompany the sanguineous and lymphatic vessels; it swells and bathes them in lymph and fat. It abstracts, for their profit, the vital action which ought to be received by the muscular fibres. This double cause, the superabundant vitality of the cellular tissue and the pressure which it exerts on the muscular, which is no longer kept in activity by exercise, finally brings about the absorption of all the molecules of fibrin, and the organ is lost to its primitive destination. It no longer receives the same quantity of blood; it has lost its temperature, and ceases to correspond with the centre of perception. The aponeuroses, tendons, ligaments, finally, all that is not fibrin, all that is purely gelatinous, remains, but in a more or less altered state. The vessels are not destroyed, but, as the limb consumes very little blood, they are diminished in size. If the pains are considerable, if the neurilema be inflamed, the nerves remain, and may even have acquired developement: but this growth is pathological, it is a gelatinous hypertrophy, which is not by any means favourable to muscular contraction, the instruments of which have, moreover, disappeared. If there have been no pains, the nerves also are atrophied; or

if they still seem to possess any volume, the nervous substance, properly so called, is no longer met with in them.

This degeneration is then still a disease of the internal exhalent tissues, and it is their irritation that deranges the functions of the body. It would not by any means be physiological to desire to attribute these fatty and albuminous growths to debility, still less to a rheumatismal diatheses of a particular kind, or to a humour. Rheumatism is truly a disease of the gelatinous and muscular tissues simultaneously; but this disease, which is only an irritation, by rendering the contraction of the muscular fibrin painful, condemns it to repose, and thenceforward the entire vital action is diverted from this fibrin and fixed on the tissues which are interposed between the muscular fibres. The tendinous capsules, and all the adjacent cellular tissues, also participate in this irritation, whence result fatty and gelatinous engorgements round the tendinous attachments, as well as round the articulations.

In paralysis from irritation of the brain or muscular nerves, we meet with a somewhat different degeneration; we see the areolar tissues injected with a gelatino-albuminous lymph, to such an extent even that the limb seems œdematous; but the lardaceous growths are not so frequent, because the irritation is not sufficiently intense to form them. The fluids driven by the circulation arrive also in the gelatinous areolæ, and the diminished power of absorption compels them to remain there, and hence results the œdematous state of which I spoke.

If the inflammations of the sanguineous vascular system, whether in the skin, or in the mucous membranes or their appendages, can be transferred to the cellular tissue, that of the ganglions and lymphatic vessels runs into it with still greater facility. It is in the glandular phlegmasiæ of the extremities, which form a knotty cord along the course of the lymphatic vessels, that we meet with the most extensive phlegmasiæ and most abundant suppurations; and when these adenites pass into a chronic state, whole limbs are seen converted into great albuminous or lardaceous masses, as in the glandular disease of Barbadoes. Thus the external adipose tissue is placed between two others from which it may receive irritation; the skin on one side, as we see in the elephantiasis of the Greeks, which begins by the inflammation of this envelope, and on the other side the lymphatic vessels, the neglected inflammations of which give rise to those monstrous engorgements of which I have

spoken above, and to which is referred the elephantiasis of the Arabs. In all these cases there is hypertrophy and vicious irritation of the cellular tissue. Such is also that peculiar disease of the cellular membrane in new-born infants.

The medullary membrane of the great cylindrical bones, and even of those of the spongy kind, abounding in diploe, receives irritation from external violence; irritation likewise penetrates there after being developed in the articular ligaments of the gouty and rheumatic, and after syphilitic irritations which had commenced in the mucous surfaces of the genital organs. Hence those swellings of the bones, called *spina ventosa*, in which enormous lardaceous masses are developed in the medullary canal, cause a diluting, thinning, and softening of the external surfaces of these bones, formerly so hard, and terminate in the carcinomatous degeneration. These diseases are, it must be acknowledged, of rare occurrence: but they do exist, and they furnish us by means of the pains that accompany them, a certain proof that the irritation developes the nervous matter, which was lost in the medullary tissues, rouses them from the torpor of their normal state, and establishes extraordinary sympathies between these same tissues and the organs of relation. All these extraordinary points of irritation,—cellular, serous, osseous phlegmasiæ, are, in my way of thinking, accidental senses, because it seems to me that inflammation, by heating and softening them, renders them somewhat analogous to the senses in a normal state, and places them, like these latter, in relation with the centre of perception, the only medium of the sympathies of relation. The tumefaction of the spongy bones, their softening and caries, can only be considered as an effect of the inflammation always chronic, or rather of the sub-inflammation that prevails in the medullary membrane placed by nature in the cells of the diploe. It was at one time a matter of serious dispute, to ascertain whether or no caries ought to be ranked among inflammatory diseases; we class it, without hesitation, in the series of the phlegmasiæ of the internal exhalent tissues.

There is a peculiar state of the animal economy which singularly favours the transmission of irritations, formed primarily in the tissues of relation, to those destined for the internal exhalations; it is designated by the title of *scrophulous affection*. We shall meet with it again in the etiology of the diseases of the lymphatic system, properly so called, and on that occasion I propose inquiring under what circumstances it is established in the human body. I

may, however, remark by the way, that this diathesis is distinguished by an extraordinary irritability of those tissues, which act on the albuminous and oily portion of our humours, without even excepting the most dense ones, and which receive it while they repel the red molecules, or which only admit them in a state of decomposition, and with a slowness of movement opposed to the free developement of inflammation. Such is, at least in my opinion, the reason why irritations of these tissues exhibit a character totally different from those manifested in most others; and it is this well marked difference which induces me to appropriate to such kind of affections, a word, which, without erasing them from the list of irritative diseases, serves still to distinguish them from common phlegmasiæ: this word, as already known, is *sub-inflammation;* but as I propose recurring to this topic, I shall not now make any efforts to convince practitioners of the necessity of admitting this expression, or of finding another which shall give precisely the same idea.

Polysarchia, or obesity, is the effect of a superabundance of nutritive materials, which are thus placed in reserve under the shape of fat in the cells of the adipose tissue. It would be difficult to explain, not why it is created, but rather still more, why all persons who eat much and who do not use exercise proportionate to their locomotive powers, are not thus affected: be this as it may, this exuberant fat impedes all the functions, and constitutes a diseased state, which has its origin in the internal exhalent tissues. We do not find accumulations of serosity supervene in the laminated tissues and serous membranes, unless predisposed thereto by disease: dropsy is in fact never seen, like obesity, in the normal state; but we find that persons who are very fat, are much more liable to serous collections than those who are lean and haggard. The explanation usually given is in the alleged relaxation of the fibre; but can such relaxation, regarded as bordering on a pathological state, be compatible with the exuberant hæmatosis which we always observe in persons loaded with fat?

The membranes secreting the humours of the eye, contract irritation by external injuries, and receive it from certain other adjacent tissues more susceptible than themselves: it is thus that blows on the ball produce an excessive exhalation, which is a real dropsy. We find this irritation likewise supervene on violent cephalalgias, which are then attended with opacity of the vitreous humour and crystalline lens. On the other hand, ophthalmias of the conjunctiva

impart to the membranes that exhale the above humours an irritative impulse, by which they lose their transparency. We meet moreover with critical phlegmasiæ of the eye, and sudden opacities, at the termination of certain acute fevers, depending more usually on gastro-enteritis with strong irritation of the brain, when these diseases have been treated by the stimulating method, or abandoned to nature. The inflammations of the retina and iris may likewise affect the internal exhalations of the eye, so that the membranes which are intrusted with them receive irritation from all the surrounding tissues, and retain it in a grade proportioned to the impetus that communicated it to them.

The arachnoid membrane, which is spread out over the interior of the petrous portion of the temporal bone, is susceptible of similar lesions; but we have not all the wished-for data to the passages by which they are transmitted to it. There is no doubt but many cases of deafness, the cause of which seems undiscoverable, owe their origin to irritation of this serous tissue, the humour of which is thickened and condensed, and compresses the acoustic nerve, causing at the same time its absorption. Fresh researches ought to be made on this point of pathology.

CHAPTER XI.

OF GENERAL ABSORPTION.

Absorption is that function of the animal economy which introduces into the blood-vessels the materials necessary to the performance of the other functions. It is exerted, 1. Upon the fluids assimilated in the digestive canal; 2. Upon those which are susceptible of admission through the other mucous surfaces; 3. Upon those which are exhaled upon the serous membranes and in the areolæ of the laminar tissues; 4. Upon the oily fluids deposited in the adipose and in the medullary and diploic tissues; 5. Upon the humours of the eye and of the internal ear; 6. Upon the interior of the excretory canals; 7. Upon the cutaneous surface; 8. Finally, absorption is exercised at the expense of the proper fibres of each organ and parenchyma.

The first of these absorptions has been described when treating of the digestive function. It is performed, as we have seen, by ves-

sels forming a particular system, or a considerable branch of the general lymphatic apparatus. Among the other absorptions, some take place by vessels which are distributed to this last apparatus; others are supposed to be exercised by very short vessels which go directly to the venous radicles, after traversing a very short space. But besides these, it is suspected that there exists an absorption which cannot have peculiar vessels, and which may be nothing else but a separation of the molecules of the solids which would be drawn along by the fluids extravasated at the moment when they traverse the parenchyma; but this latter forms part of the phenomena of nutrition, in which we meet with the composition and decomposition of the solids. This last will therefore be reserved for the following chapter.

General lymphatic absorption is the only one, the agents of which we can demonstrate: we proceed, therefore, to present an abridged description of these, proposing to treat afterwards of that supposed to be carried on by small lymphatic vessels, which run directly into the venous radicles.

Section I.—*Summary Description of the Lymphatic or Absorbent System.*

The organs of absorption are divided into two classes: 1. Lymphatic vessels; 2. Lymphatic ganglions. The lymphatic vessels are tubes entrusted with the office of transmitting to the venous system the fluids absorbed at the surface of the membranes or in the tissue of the organs. They form two planes; the one superficial, the other deep-seated: the first or subcutaneous, covering all the body and all the surfaces of the internal organs; the second dips down into the interior of the tissues, forming there a kind of fasciculi that surround the blood-vessels, the direction of which they follow. These two planes communicate frequently with each other by anastomosing branches, or in plexuses common to both.

The arrangement of the absorbent radicles, or the origin of the absorbent vessels, is entirely unknown. When the lymphatic vessels begin to be perceptible, they are already at a distance from their origin. Their volume is less than that of the arteries and veins, and their form cylindrical: but they present at different intervals dilatations of a greater or less size, which correspond to the valves situated in their interior.

These vessels originating in all parts of the body, unite, anasto-

mose, and form plexuses passing through the lymphatic ganglions; whence arises the distinction of lymphatic vessels into *afferentia* for those which arrive in the ganglions, bringing the fluids that they have absorbed; and into *efferentia* for those which go off from these ganglions, conducting their fluids into the venous system: finally, these vessels empty themselves by several trunks into the subclavian and internal jugular veins. Two of these trunks are much larger than the others: they are called, the one *thoracic duct*, the other *great right lymphatic vein.* This last, equalling almost in size the thoracic duct, is extended obliquely to the right, upon the tranverse apophysis of the last cervical vertebræ, and opens at the angle formed by the right internal jugular and subclavian veins, after a course of about a third or a fourth of an inch.

The *lymphatic ganglions* are small bodies of a different form, though generally rounded, and varying in dimensions from the tenth of a line to the size of a filbert, and situated along the course of the lymphatic vessels, to the number of six or seven hundred, but they are collected in the greatest number in the vicinity of the articulations, in those parts where the cellular tissue is most abundant, as the groins, the arm-pits, the lateral and inferior parts of the neck, and in the thoracic and abdominal cavities. They are designated by their situation, according to the region which they occupy: upon one side they receive the lymphatic vessels which have absorbed the lymph; on the other they give passage to those which convey it into the venous system. The texture of the vessels and lymphatic ganglions has been before described, when treating of the digestive function.

Section II.—*Physiological Action of the Absorbent System.*

Although all the absorbent vessels communicate with each other, it is very evident that the lymphatic ganglions are met with more particularly upon the route of the absorbents which return from the skin or from the internal surfaces of relation; in fact, all those of the exterior terminate in the ganglions situated about the articulations, in the groins, and the cervical region. These last are also in relation with the lymphatics which arise from the salivary ducts and from the mucous membrane of the mouth: the internal surface of the digestive canal conveys its absorbents into the ganglions of the mesentery, and of the different omenta, and these ganglions communicate with others which have received the lymphatics aris-

ing from the excretory ducts of the bile, and from those which belong to the pancreas. The lymphatics of the bronchiæ and of the lungs terminate in the ganglions called bronchial, which are situated, in part, about the ramifications of the bronchiæ, and in part in the mediastinum. From the urinary surfaces, and from those of the genital organs, the lymphatics run either to the ganglions of the abdomen, or to those of the groins. From this we see that the ganglions are disposed in such a graduated manner, that the fluids entering from those of the exterior, in following the passage of the lymphatics, pass successively into others more deeply seated, until they have reached the central lymphatic trunks which are to deposit them in the veins that convey them to the right auricle, consequently into the current of black blood.

The lymphatic system is then an appendage of the great general venous system. This arrangement was unknown at the time of the discovery of the circulation: the veins, in the opinion of all anatomists, were intrusted exclusively with the different absorptions. They were deprived, however, of this office after the labours of Mascagni, Cruikshank, &c., and all absorption was attributed to the lymphatic system. At the present time opinion begins to be divided: no one denies to the lymphatics the office of conveying and depositing certain fluids into the large veins near the heart, after having made them traverse a long course; but it is thought that we ought to admit a much shorter passage for other fluids, which, from the surfaces where absorption is carried on, must be introduced immediately into the venous radicles. We may express ourselves in the manner of the ancients, by saying that the veins absorb. The experiments tending to prove this fact will be found in the different works of M. Magendie.* We had at first thought that it was exe-

* M. Magendie insulated by two ligatures a portion of intestine, dividing with great care all the chyliferous and lymphatic vessels, arteries, and veins, with the exception of a vein and an artery; he then divided the intestine, above and below the two ligatures, in such a manner that it had no connexion with the remainder of the body, other than by this single vein and artery; he injected into it a decoction of nux vomica, and, in six minutes afterwards, the effect of the poison was manifested. M. Segalas, a pupil of M. Magendie, repeated this experiment, but he left no communication between the portion of the intestine with the remainder of the body, except the chyliferous vessels,—all the arteries and veins being divided; he injected half a drachm of the alcoholic extract of nux vomica, and the poisoning did not take place, even after half an hour; but when he freed one of the veins which had been merely tied, and not divided, the poisoning took place immediately. Others have nevertheless detected, (Tiedemann and Gmelin,) substances not alimentary, (prussiate of potass,) in the thoracic duct.

cuted by small canals, which, after having obtained from the surfaces a fluid different from the blood, water for example, deposit it, after a passage more or less short, in the venous radicles; which would establish two classes of lymphatic absorbents: the first, forming part of the general system, would be the great lymphatics; the second, without any communication with this system, would be called the small lymphatics, or the short absorbents. But to sustain this opinion, we ought to be assured that absorption is always performed at its origin, by organized canals; which it is impossible to affirm, since dissection has not enabled us to distinguish the particular absorbent mouths. It might indeed happen that the fluids, deposited upon the surfaces, were pumped up in virtue of the affinities of vital chemistry, and at first in a true state of extravasation, introduced molecule by molecule, between those of the fixed animal matter, and that, there confounded with the blood also extravasated, these molecules might be seized upon sometimes by the venous radicles, and sometimes by those of the general lymphatic system, according as their affinities would direct them towards one or other description of vessels. The greatest obscurity still exists on this point of physiology which forms part of the mysteries of the capillary circulation, a circulation which obeys, as we have already seen, the unexplained laws of the molecular affinities of vital chemistry. If the phenomena of absorption were performed in this manner, it would be correct to say that the veins absorb; but it would remain to determine what are, among the substances submitted to absorption, those which ought to traverse the great lymphatic system, before being admissible into the veins, and those which are privileged to penetrate immediately into these vessels, after they have been pumped up by the animal matter of the surfaces. The following are some data, which, it seems to us, might serve as a means of leading to this discovery.

Since the most considerable lymphatic ganglions are found in the route of the fluids which traverse the absorbents of the surfaces of relation, may it not be presumed that these ganglions co-operate in assimilation? Their structure supports this conjecture, for they do not consist entirely of convolutions of lymphatic vessels, but are also parenchymæ, having a proper tissue, nerves, and sanguineous vessels—arterial and venous. The lymph which reaches them cannot, then, remain in condensed columns, as it was in the vasa afferentia, but must be extravasated there and submitted to the action of the vascular affinities which modify it, so that, when taken up

by the vasa efferentia, it has made some progress in assimilation. If the necessity or even utility of this elaboration be admitted, we can conceive that the fluids imbibed by the different surfaces should be divided into two kinds: the one will be admitted directly by the radicles of the veins; the other will be attracted towards the great lymphatic apparatus, and will have to traverse it before mixing with the blood. Now, our modern physiologists have admitted this division upon the surface of the digestive canal; if we are to believe them, the chyle arising from compound solid aliments must necessarily traverse the mesentery, and, consequently, the ganglions which it contains; whilst water, absorbed directly by the veins, can enter into the blood, and thus avoid this long circuitous route. But if this be the case, how would the absorption of poisons by the venous system be explained?

Do the absorptions which are performed from the serous membranes, the synovial capsules, the areolæ of the laminar tissue, the cells of the adipose, medullary, and diploic membranes, those of the humours of the eye, the arachnoid, &c. terminate in lymphatic ganglions? It would be rash to affirm that this is indispensable; for the ganglions that are met with in some of these tissues may be destined for the fluids taken up from the surfaces of relation. This much is certain, that we never find any in the interior of the cranium, where absorption does not convey any fluid coming from the exterior. It is generally believed that the serosity of the arachnoid membrane enters directly into the small veins of the pia mater.

Be this as it may, we cannot confidently affirm, that the lymph, absorbed from the tissues which have no communication with the exterior, never penetrates into the lymphatic ganglions; all that we can say is, that it need not of necessity pass through them, and that, among the fluids taken up on the surfaces of relation, there are some which are not required to take this course, such as pure water, alcohol, &c. whilst others must necessarily be submitted to the influence of the ganglions, and traverse the whole extent of the lymphatic system before penetrating into the blood-vessels.

It may still be demanded, if, among all the fluids which are absorbed directly by the surfaces, there are not some which, from the capillary system, may reach secreting organs without going through the heart and the lungs. Many anatomists have asserted, that water, absorbed in the digestive canal, penetrates directly to the kidneys; but as there have never been found any particular vessels for its conveyance, it would be necessary to admit a kind of retrograde

movement, which should cause it to pass from the capillaries of the intestines into the renal arteries; and this would be a purely hypothetical assertion.

At any rate, the rapidity of urinary excretion following the abundant ingestion of water is greatly analogous to that of perspiration, which occurs in preference when the skin is much stimulated, as is observed every day during the heats of summer. In fact, scarcely has a man, whose skin is greatly excited by heat, swallowed water, when immediately the perspiration shows itself in abundance. It will doubtless be alleged, that it is not the water drunk which can make its way to the surface in so short a period; but here is another fact well worthy the attention of physiologists. In former times, when the question was put by water, the accused was made forcibly to swallow a quantity of this liquid, so that the stomach was horribly distended. Well, what was done to preserve him from the ill consequences of this excess? The abdomen was exposed to the heat of an open stove; immediatety the sweat poured out abundantly from the whole of the skin, and particularly from that of the abdomen, and in some minutes the bulk of this part was reduced to its ordinary dimensions. It was facts of this kind, and others of an analogous nature, which induced Bordeu to believe that the fluids traversed in every direction the cellular, which he called mucous tissue. We confess that there still exists much obscurity on this point of physiology, and that we do not yet know enough to enable us to explain in a satisfactory manner why the liquids submitted to absorption take the course of the blood-vessels, rather than that of the great lymphatic apparatus. As respects ourselves, we will merely say, in a general manner, that the fluids which follow this course appear to us to be those which, coming from the exterior, require a previous elaboration in the ganglions, before penetrating into the circulatory apparatus; but we do not flatter ourselves with giving the explanation of the exceptions to which this law shall be liable.

Absorption is performed in an uninterrupted manner; but many circumstances cause it to vary. The facts just related prove that whenever an excretion is increased, absorption is so likewise in the same proportion; consequently it must be admitted, that when the sweat flows out abundantly, contractility is singularly increased in the lymphatic system, and in the veins. But are we to believe that the pulsations of the heart are accelerated in the same proportion? We do not think that this condition is indispensable. We sometimes

see, that, under the influence of diuretics, absorptions suddenly take place, which carry off the serum collected in the peritoneum; and the kidneys eliminate, in a short time, all this fluid, without any increased frequency of the pulse taking place; yet we must concede that the acceleration of the systole of the heart is favourable to absorption, and gives rise to more multiplied movements in the vascular, and consequently in the lymphatic apparatus; and thus the state of fever always increases absorption. We say *more multiplied movements*, because it appears to us that the absorbent vessels must, like the veins, act upon their fluid, by alternations of contraction and of relaxation, although it may be impossible to perceive them: perhaps at some future period that instrument will be discovered which shall render them perceptible. (U)

The mental affections have a notable influence on the phenomenon of absorption; it is known how far they can increase the action of the secretory vessels; and we have already remarked that elimination ought necessarily to augment absorption. It is the observation of this last relation which has directed physicians to the prescription of purgatives, diuretics, and sudorifics, to persons whose lymphatic and ganglionic system is overloaded with lymph or who labour under what is called *obstructions*. The advantages of this kind of modification are nevertheless limited by the super-irritation which the stimulants employed produce on the mucous lining of the digestive tube; for whenever it becomes immoderate, the secreting vessels do not act, and the tissues loaded with lymph attract an additional quantity, in place of freeing themselves from what they had before.

The absorbent apparatus is so much the more active as man is less advanced in life. The action of this system is truly astonishing during early infancy; it preserves much of its energy in youth; it diminishes in proportion as the decline of life approaches, and becomes very feeble in old age. In women, absorption is less rapid than in men; it may be considered as existing in the highest possible degree among persons of a rigid and robust habit, whilst in subjects of an opposite constitution it is always very feeble.

SECTION III.—*In what manner the Absorbent System becomes disordered.*

In order to comprehend correctly the etiology of the diseases of the lymphatic system, it is sufficient to call to mind the stimula-

tions which it is accustomed to obey, and what are the organs which sympathise the most with its ganglions. Now, the stimulations which cause the absorbents to act are those of the membranes of relation, and the organs which sympathise the most with these ganglions are likewise these same membranes. In fact, when the stimulation caused by foreign bodies placed in contact with these surfaces determines them to the performance of absorption, the action of all the lymphatic vessels thence arising, and the ganglions in which they terminate, is necessarily increased: such is the chief cause of glandular phlegmasiæ; for it is of little importance what may be the object of the stimulation experienced by the membranes of relation; whether it be occasioned by the want of absorption or by some other cause, it is sufficient for it to exist, in order that irritation should be developed in the lymphatic apparatus. We have already seen that inflammation of the internal mucous membrane of the digestive canal could produce that of the ganglions of the mesentery. Now it is the same case with the phlogosis of the skin: when it exists, the ganglions to which the lymphatics of the part are distributed simultaneously become diseased; hence buboes of the groins in catarrhs of the external genital mucous membrane, and even in inflammation of the toes. All erysipelatous affections cause the adjoining glands to tumefy; inflammations of the mouth, as also those of the face and neck, produce the same effect upon the cervical ganglions. Let there arise a phlegmasia on the hand or the fingers, do we not immediately perceive the glands of the arm-pit, and all the lymphatics which pass to it, take on a state of inflammation? Let the mucous membrane of the bronchiæ be inflamed, the bronchial ganglions become tumefied; and, if the catarrh continues, they experience a real phlegmasia. It is then a fixed law, that irritation may be transmitted from the surfaces of relation to the lymphatics and neighbouring ganglions.

I have endeavoured to satisfy myself whether the inflammations of the serous membranes produce the same effect as those of the mucous in the visceral cavities, and I have had reason to be convinced that this relation does not exist: the peritonites, and pleurisies, do not induce the swelling of the glands of the mesentery nor those of the mediastinum; and whenever they are altered in the bodies of those who have died from such phlegmasiæ, we are certain to find a complication of enteritis or of bronchitis; which confirms the conjecture hazarded above, that the fluids absorbed by

the membranes called serous need not necessarily traverse the lymphatic ganglions.

Although simple inflammation, *absque materiâ*, of the skin or any other membrane of relation, is sufficient to cause a tumefaction of the ganglions which receive lymphatics from it, we confess that this influence is much more marked if the phlogosis be caused by liquid matters, very acrid and capable of rapidly traversing the absorbent apparatus. It is thus that inflammations of the arm, after inoculation of the vaccine virus, and those of the fingers caused by a very acrid matter in dissections, act rapidly upon the lymphatics of the limb, which become phlogosed, forming a knotty cord with a reddish line, and soon become complicated with inflammatory swelling of the axillary glands.

Ought not this fact to throw some light on pestilential buboes? I for my part believe it; for if the plague is caused by a peculiar miasmatic poison, this might have an affinity with the lymphatic apparatus, and, whether it penetrates to it, after having been absorbed by the skin, or whether it reaches it by circulating with the blood, its presence is sufficient to excite inflammation of the ganglions the most disposed to contract it. In the histories of this disease, we hear of nothing but sub-cutaneous buboes; it remains now to inquire whether the glands of the mesentery are not in this disease more voluminous and more inflamed than we are accustomed to find them in the most common sporadic gastro-enterites. The same investigation should be made with respect to the ganglions of the mediastinum, for it appears to us that the mucous membrane of the bronchiæ must frequently, during the time of a plague, participate in the inflammation of that of the stomach and intestines. I have distinctly said, that in certain epidemics of our climate gastro-enterites are much more frequently accompanied by ganglionites of the mesentery than in others; this difference is perhaps owing to the presence of some miasmatic poison, the source of which is not well known; perhaps also it is dependent on the moisture of the atmosphere: what induced me to think so is, that those years in which I found the ganglions of the mesentery most affected, have been very rainy, whilst those in which ganglionites were most rare, have been very remarkable for their dryness.

This observation leads us to remark the influence of cold, and particularly of cold with moisture, upon the lymphatic ganglions, which is clearly manifested upon subjects of a scrofulous constitu-

tion. In fact a cooling of the surface suffices, without the co-operation of any cutaneous inflammation, for a painful and truly phlogistic tumefaction of the glands of the neck to supervene. It is in this way that those engorgements of the nose, lips, ears, and cervical glands observed in spring and autumn in young subjects, whose skin is delicate and sensible, are most frequently excited. If the constitution be vigorous and sanguine, there results, in the glands or in the sub-cutaneous tissue of the face and neck, abscesses which often run through their period on to suppuration, even in a very short time; but if such diseases be more lymphatic than sanguineous in their nature, the adenites do not progress with so much rapidity: they become chronic, and it is then that they take the name of scrofula. In our opinion, it is solely to the predisposition of the subjects that this difference must be attributed, and we shall now endeavour to support this opinion by the best authenticated and most familiar facts.

Man ranks on the highest degree in the zoological scale as regards the extent of respiration. In his character of a warm-blooded animal, he is destined to live in an atmosphere unconfined and abounding in oxygen. If he is deprived of this first condition, his lungs do not attain that degree of developement of which they are capable, and the other organs are weakened in the same proportion; the muscular apparatus particularly can acquire neither volume nor strength, because its vigour is closely connected with that of the lungs. Under these circumstances man sinks below his original type. From this we perceive that, when confined from his earliest years in the enclosure of badly-aired cities, and deep and narrow valleys, he must necessarily degenerate.

But this is not all: when the air which surrounds him is not sufficiently renewed, he is necessarily deprived of light, and saturated with water. This double cause of debility adds always to the first, for the want of light is to man the privation of a stimulus necessary to his growth. It is in vain for him to obtain abundant nutriment; he cannot derive any benefit from it, if these organs are not rendered fit for a perfect assimilation by air adapted to the wants of his system. He will then under such circumstances make a bad use of the nutritive materials, and his developement will never be complete. But if we add to these two causes of weakness the humidity with which the air he breathes is saturated, we shall find that the abundant evaporation, which always takes place from his own body, will not be dissolved; his vessels will then remain sur-

charged with lymph; he will become chilled, particularly if the air is deficient in caloric; he will no longer have sufficient fibrin, and colouring matter; he will not regain regularly his heat when it has been abstracted, and his tissues, moistened and relaxed, will not have that readiness to free and energetic inflammation, which is remarked in those of his species who live in diametrically opposite states of the atmosphere. It is thus that a diminution of the respiratory power will bring on a degeneration of the temperament of man, and will render him more predisposed to lymphatic maladies. Let us now proceed to investigate the manner in which they are developed, and what relations connect them with other irritative diseases.

The deficiency or the weakness of the power which presides over the composition of the tissues, must, in our opinion, produce a double effect: 1st. To render the solids less coherent; 2d. To establish a plethora of the lymphatic fluids: is it not in this that consists the predisposition to scrofula, or the *scrofulous*, called also *strumous diathesis?* But in what part is this disposition more particularly manifested? Is it not in the gelatinous parts, at a distance from the centre, and where the sanguineous system has the least degree of predominance? It will be then the tissues which compose the frame of the body, the fibrous membranes which cover it, the tendons, the ligaments, the lymphatic vessels, and the subcutaneous ganglions, which will be the first affected. But what will communicate the irritation to them?

The skin, a membrane formed of gelatinous tissue, abounding in white capillaries, either lymphatic or secretory, posseses in fact a sanguineous net-work; but during infancy it has not yet acquired the degree of power to which it is destined. Nothing is easier produced, under the influence of cold, than a diminution of the sanguineous circulation of the skin, and that of the cutaneous transpiration. The power of reaction is not however entirely deficient; the skin, chilled at every moment by the subtraction of its caloric, has still a tendency to become heated; but these efforts, constantly renewed, over-irritate it. It takes on an inflammation, which, becoming predominant in the white vessels, on account of their softness and extreme irritability, gives rise to the first scrofulous engorgements—those of the lips, cheeks, ears, nose, fingers, and feet; hence, among the white tissues, the most active and the most sanguine become first irritated; they possess action sufficiently to contract irritation, but not enough to experience it to that extent which

induces us to call it sanguineous. They claim it, therefore, in that degree which we call scrofulous.

This first impulse being given, under the influence of alternations of heat and cold, it is understood that it ought to be repeated in similar tissues, which, although situated beneath the former, are still superficial, and scarcely participate in the vivifying influence of the internal functions. They possess for their preservation in adult age, firmness of composition, and the natural cohesion of their molecules, which render them but slightly irritable; hence they are affected with more difficulty; but, in infancy, they are tender and excitable, and have not yet acquired these qualities so necessary to the preservation of the harmony of the functions.

They must then receive the inflammatory impulse: and so accordingly they do in a greater or less degree in all children, and particularly in those subjects in whom the force of aggregation has little power, that is to say, in scrofulous constitutions. In this manner the irritation, developed in the skin, being communicated to the sub-cutaneous ganglions, swells and hardens the cellular tissues, softens the ligaments and tendons, and the lymphatico-adipose masses found about the articulations and called improperly synovial glands, and penetrates to the cartilages and even to the bones, attacking first the most spongy and those which form the articular surfaces; in a word, the scrofulous irritation, developed in the gelatinous tissue of the interior, advances from the more soft to the harder parts, unless some accident arrest its progress.

But, while indicating here the action of cold as a determinate cause of scrofulous affections, we are far from wishing to insinuate that it is the only one. Every thing which excites irritation in the tissues that are susceptible of it, without producing an evacuation which shall unload them, can produce the same result. Scrofulous irritation may then commence in the midst of tissues, which in ordinary cases it affects only secondarily: it is in this manner that contusions are observed to immediately develope strumous inflammations in the cellular tissue and in the articulations, whilst simple wounds made by cutting instruments, heal with great facility, particularly when there has been a copious hæmorrhage. These are very notorious facts, and cannot fail to aid in elucidating the question which now engages us.

The sympathetic irritation excited by the influence of the mucous membranes adjoining the skin, and even by the influence of that lining the large viscera, may likewise, by acting on the surface,

give rise to the scrofulous inflammation when the predisposition is firmly established: it is in this manner that the phlegmasias of the interior of the mouth affect quickly the cervical ganglions, and even the salivary glands; it is in virtue of this law that gastritis produces amygdalites and strumous ophthalmias in children possessing this unfortunate constitution, and gives rise on the skin to scabby eruptions, which evince all the characteristics of scrofulous inflammation.

There are some individuals of the human species who pass through all the periods of infancy, and even of youth, without the scrofulous diathesis, under which they labour, manifesting itself by any appreciable sign. The softness of their flesh, and the little firmness of their ligaments and bones, were the only evidences of it even on to adult age. But this period arriving, an accidental irritation is often sufficient to demonstrate all the evils attending this kind of organization. It is in these subjects that the confinement in a gloomy and damp place, such as a prison; the suppression or the cessation of a habitual evacuation, such as the menses; an itch taken by means of contagion; ringworms excited by external causes, or chronic gastrites; the suppression of mucous drains, or of a habitual suppuration, produce suddenly scrofulous inflammation, so much the more intractable as there does not exist a prospect for their healing, derived from the changes at puberty. It is also in virtue of this very deplorable diathesis, that we observe so many persons a prey to interminable affections of the skin, of the mucous membranes adjoining the exterior, of the ligaments, periosteum, cartilages, and even of the bones, when they have been so unfortunate as to contract a syphilitic phlegmasia. The more they are stimulated by real or imaginary specifics, the greater is their suffering; the point of irritation continually changes its situation; and too often their maladies terminate only at the moment when the stimulants with which they are overwhelmed, have produced, in the viscera, a phlegmasia that causes their death.

In fact, although the irritation called scrofulous commences in the organs of the surface, it can in a very great majority of cases reach the viscera; and it is unfortunately almost always under the influence of medicines which are thought to be able to arrest the disease that this dreadful epigenesis or new series of symptoms is manifested. The viscera, being warmer, and plentifully supplied with blood, resist it at first, and contract only irritations purely sanguineous, susceptible of a radical cure; but if we neglect to combat

them by appropriate means, which destroy them in other subjects, or if we obstinately persist in the use of tonics, the internal white tissues are finally roused into action; and as the scrofulous predisposition, though less in the interior than externally, still persists, the viscera are infarcted with lymphatic engorgements which no longer admit of any hopes of cure. The same defect of nutrition which produces the scrofulous predisposition, may also become predominant in the osseous system; then the bones, no longer incrusted with calcareous phosphates, remain flexible, and yield to the weight of the body and the action of the muscles, thereby giving rise to many deformities. These unconsolidated bones are very often extremely irritable, and contract slow phlegmasias, which produce engorgements of the surrounding soft parts. The same remark may be made respecting the progress of this disease as upon that of the preceding, with which it is often complicated.

But there is a viscus, the affection of which is still more intimately connected with osteo-malaxy; whenever the ossification of the bones of the cranium is retarded, the brain, whose increase is not then confined by them, takes on an extraordinary developement, which it retains during life: very frequently this hypertrophy becomes morbid in the pulp, which degenerates, and there takes place in the ventricles an irritative exhalation of serosity, producing what is called hydrocephalus. It is difficult to determine whether this abnormal growth of the encephalon be not sometimes dependent upon a primitive irritation of its tissue, rather than on a defect of cranial ossification; but it is always certain that one or other defect exists with regard to the diversion of the nutritive materials, which, not receiving their normal direction, on account of the weakness of assimilation, and the languor of the eliminating power, establish a lymphatic plethora very favourable to the developement and irritation of the white tissues.

The exuberant nutrition of the abdomen is also manifested in the scrofulous disposition, when there is connected with it a slight enteritis, either by an enormous enlargement of the liver and swelling of the ganglions of the mesentery, or in consequence of the gases which the irritation of the membrane unceasingly furnishes. The lungs have not been observed to participate in this hypertrophy: on the contrary, the curve of the softened ribs, and the sinking in of the sternum, produce a narrowing of the thoracic cavity, and compression of the lungs and heart, which retards the passage of blood through these organs, forces it to stagnate in the

head and abdomen, and to favour the plethora and the exuberant nutrition which render those organs liable to inflammation. But at a later period, when puberty directs the last effort of growth towards the thoracic viscera, we then see them contract an irritation so much the more violent, as the solid bony walls do not yield to their enlargement; and, if the scrofulous diathesis still exists, the inflammation of the glands will succeed that of the sanguineous vessels, and there will be great danger of the occurrence of phthisis.

It is in this manner that the retardation of the general growth, and the weakness of the lungs, caused by the want of air, and of light, and by the influence of moisture, after having produced, during infancy, scrofulas and osteo-malaxy, become, at a later period, the cause of the most fatal visceral inflammations. Let us now examine in what light this diathesis should be regarded.

We have seen that it is founded on an abnormal irritation of the gelatinous tissues, in which the sanguineous circulation is languid; and a very marked irritability of those parts which, in a normal state, are the least irritable; that in virtue of this disposition, these tissues contract irritation during the operation of ordinary stimulants upon the economy; that, when thus irritated, they invite the lymph, become tumefied, and undergo a kind of suppuration which is peculiar to them. This progress of things is somewhat analogous to that of sanguineous inflammation, and yet it should be distinguished from it; the precision of medical language demands it, and still the words in use do not attain this object. Shall we employ the word *scrofula?* It is founded upon the resemblance of the lymphatic affections of man to those of the hog, (*scrofa*,) and does not convey an idea of the physiological modification taking place on these occasions. Shall we adopt the expression of *white engorgement?* It does not indicate any better the physiological modification, and, besides, it recalls ideas of obstruction through weakness, or a supposed coarseness of the molecules which would be disproportioned to the caliber of the vessels. The expression *infarction* is no better. There remains that of *lymphatic inflammation;* but if we wish to designate fully this class of irritations, the above is not a suitable term; for it supposes inflammation, with all its properties, in the white tissues, which is by no means the fact. This inflammation is possible in some of them, such as the ganglions, the secretory glands, the cellular tissue, and the serous membranes; but it does not always exist in them, and the tumours adduced as examples are the very ones in which it is not present. Shall the

term *chronic* be added? This will still demand an explanation: it will be necessary to say that the chronic inflammation of the white tissues bears no analogy to that of the sanguineous vessels. Now, it is precisely this peculiarity that the word *sub-inflammation* expresses, which has also the advantage of representing at the same time to the mind, the chronic inflammations of all parts of the body, whenever they invite there other fluids than the blood, and produce tubercles, the lardaceous state, scirrhus, encephalocele, mœlanosis, in a word, all those degenerations which may serve as a foundation to the disorganizing ulceration called *cancer*. When sanguineous inflammation is conjoined with this, by opposing the term *sub-inflammation* to that of inflammation, we easily convey the idea of what takes place in the part irritated. Does the irritation commence slowly, confining itself to the accumulation of white fluids, it is a *primitive sub-inflammation*. Does the irritation begin by redness and heat, it is *inflammation*. Are fluids not sanguineous accumulated at the same time in the part, it is a *mixt inflammation*, partly inflammatory, partly sub-inflammatory. Are the heat and redness dissipated, the irritation becomes purely sub-inflammatory; it is a *consecutive sub-inflammation;* and as such, it must, like the primitive, be very slow in its progress. But whenever the sub-inflamed part suddenly reddens, becomes inflamed anew, and advances rapidly towards disorganization, it is because the inflammation has returned to the part, and has a second time become mixt; it is a *secondary mixt phlegmasia*.

Such is the language that we have adopted in pathology: it appears to us to express nothing more than the facts appreciable to our senses, and does not prevent each one from entertaining his own opinion with regard to the cause of the phenomena in question. Of what moment to me is the true cause determining sub-inflammation or mixt inflammation? The partisans of viruses may attribute the irritations either to syphilis, scrofula, or herpes, &c. in the same way as sanguineous inflammation is sometimes referred to the variolous virus, sometimes to the rubeolous, and at other times to miasmata; yet it will not be less useful to possess terms which shall portray each shade of these irritations. Until specifics are discovered for each of them, of which we are allowed to doubt, we shall always find in the language above proposed, the first indications to direct us in modifying irritation by the two classes of remedies with which we are acquainted, and the employment of which is familiar to us, viz. antiphlogistics and revulsives. For a long pe-

riod of time nosologists placed the variolous at the head of the inflammatory diseases: has this classification therefore prevented the discovery of vaccination? and is it not to the precision which physiological medicine has attained in the diagnosis of the seats of the irritation at the different stages of this disease, that is owing the great success which renders variola at the present day less fatal than formerly? Impressed with this important truth, that the danger of confluent small-pox is in a great degree the consequence of the violence of the erysipelas of the face, a celebrated practitioner of Lyons, Dr. Janson, applied leeches to the neck. An abundant hæmorrhage ensued from the bites; all the alarming symptoms were dissipated; the greater part of the pustules were discussed; a small number suppurated without injury; and from confluent, as it was, the variola became discreet, and the patient escaped without deformity.* We have frequently obtained similar results in the hospital of Val-de-Grace, an account of which has been given in the *Annales de la Médecine Physiologique.*

CHAPTER XII.

OF NUTRITION.

This is pre-eminently the function of the living body; it constitutes the end and object of all the others, and the organs which perform them are but the more or less remote instruments for the accomplishment of this. The seat of nutrition is in every part, since all the tissues have need of nutriment; though still the mode is different in each of them.

Nutrition is the same from the first moment of existence to the end of life; it is purely chemical, consisting as it does in two phenomena, composition and decomposition, both of which depend on molecular affinities.

These affinities are different from those observed in inanimate bodies, hence they are called *vital;* and the chemistry which sets them in action, receives the name of *vital chemistry.*

* *Compte rendu de la Pratique Chirurgicale de l'Hotel-Dieu de Lyons,* during six years, read in a public meeting of the administration of the hospitals of that city, the thirtieth of December, 1823, page 45.

They are necessarily pre-existent to what are called *vital properties*, as these latter are but the effect of the former. What, in fact, if it be not vital or organic chemistry, is it, that forms the fibre, and imparts to it both its contractility and the power of elongating itself after having been condensed ? and since sensibility is but the perception of contractility, as we have before shown, the former necessarily supposes the prior existence of organic chemistry.

But here an important question is presented to us: is this faculty of composition and decomposition distinct from matter? We conceive of matter as obedient to its laws: these are of three kinds, physical, chemical, and vital; physical in the masses, and chemical in the molecules of all bodies, but vital in organized bodies only. Physical and chemical laws are modified, but in a peculiar manner, by vital ones in the beings of this last class. Living bodies counterbalance the effects of chemical laws, but do not alter them; attraction is always the same, though acting on the living body; its effects are only moderated or suspended for a longer or shorter period. It is the same with heat, the contact of cold bodies, electricity, and water, viewed as external agencies operating on the living body; their action is only modified to a certain extent, and whenever these agents have much energy, life is unable to resist them: organized bodies are susceptible of the same modifications as inert ones: they are projected, attracted, burnt, frozen, in a word disorganized.

Chemical laws are modified in another manner: they may, it is true, when very powerful, destroy organized beings, as is seen in the effect of concentrated caustics; but they serve as a basis for the formation of these same beings, which does not happen with the physical laws. Scarcely has nutritive matter been introduced into the stomach, when the play of molecular affinities to which it had been subjected, and which prepared the way for its return to the inert state, is altered, the affinities take another tendency, and this matter is assimilated to the body with which it was placed in contact. The new kind of molecular affinities thus commenced will persist so long as the above substance shall belong to a living body, and will cease at the moment of its elimination, to be replaced by another.

Let us now reason on this fact of demonstrable truth, in order to reply to the question which we proposed to ourselves. If the same molecules can at one time be obedient to the laws of general, and at another to those of vital chemistry, and if these molecules apper-

tain to matter, it is evident that this last cannot be confounded with the laws by which it is made to move. Now the body of an animal, and of every organized being, is formed entirely of particles which had been at a prior period obedient to other chemical laws, and which will soon obey again different ones: therefore, the laws of organic chemistry can be distinguished from those of matter.

What is true in the subject before us in reference to vital, is equally so as regards general chemistry, and even physical laws, since we can conceive in a living body an action of varying power based on these latter. Wherefore physical, chemical, and vital laws, ought of necessity to be distinguished from matter.

The phenomenon of sensibility, on which are founded the exercises of the instinct and of intellect, presupposing, as we have already proved, the existence of chemical and vital laws acting on matter, cannot, for the same reason, be confounded with them; whence I naturally infer that the intellect is as distinct from matter, as are the laws of natural philosophy and of chemistry. It follows that physical, chemical, and vital laws, instinct, and intellect, are all so many phenomena, the ideas of which we derive from the modifications of matter, but which it is impossible to confound with it; and I do not see what there can be alleged against the very simple process of reasoning by which we were led to this conclusion.*

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* In announcing this truth, we have gone, we believe, as far as it is allowed for a physiologist. It is indeed quite enough for us to have distinguished matter from that which makes it move. What more could we say without trenching on the province of metaphysics? Shall we say, for instance, that sensation and judgment cannot be simple movements of the organs? We have no assurance on this subject, either by the aid of our senses or by reasoning; it is an affair of faith which is not susceptible of demonstration. Shall we say that no physical or mechanical contrivance or arrangement of tissue, can account for the peculiar modifications of sensation, odour, colour, &c.? Were we to say this and all else in a strain similar to what we meet with in the work of M. Bérard, we should only be repeating and paraphrasing what we have written, while treating of the vital properties, "that sensibility and intellect are not material, but incomprehensible results of the exercise of contractility."

But when certain philosophers maintain that sensitive and intellectual phenomena are not the consequence of organization, I am at a loss to understand them. It is alleged that matter does not give rise to them, but it is still the manner in which this matter is modified by the laws of vital chemistry, that is, the organization which renders these phenomena possible. Because we cannot conceive how the motion of organized matter gives rise to ideas, it does not thence follow that ideas are not the result of the motion of this matter. These are two essentially distinct propositions. Have we a better conception of how the movements of the organs can produce the sensations and acts in animals, referred to instinct? Do we understand with greater clearness how molecular attractions cause the changes in the forms of bodies? Assu-

The laws of which we now treat are referred to forces or powers; this manner of expressing ourselves does not affect the reality

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redly not: but yet we are certain that these changes are the consequences of the play of those affinities.

M. Bérard avers that the sentient power ought to be considered abstractedly from matter, whether governed by known physical and chemical laws, or animated by vital properties, irritability, contractility, &c., and abstractedly from the organs studied singly. I agree readily to this, but I maintain that considerations of this kind are not within the province of the physiologist, who ought only to study the intellectual phenomena as causes or as effects of the modifications of living matter, under the penalties of exceeding the limits of his authority.

To tell us that these phenomena can be studied otherwise, is teaching us nothing new; we possess a vast collection of treatises of this kind; but to add that the physiologist ought to do this, is equivalent to asserting that he ought not to be a physiologist. Now he who studies the physical and moral relations of man is a physiologist, and it does not become him to study the sentient power otherwise than in its relations with the organs. These strike our senses; and, whatever effort we may make to conceal them, we can never succeed. To say that the organization of the brain is only a condition for the exercise of thought, is still saying that we do not think without a brain; but if we can only think when we have a brain, it must necessarily be because we possess this organ: now, if we can only think because we have a brain, it seems to me very probable, that thought takes place by its instrumentality. It remains to explain the wherefore; but, since it is admitted that we cannot accomplish this task, it is in my opinion most prudent not to engage in it. In all these cases, I, however, am only to be understood as speaking of the physiologist and the physician.

I would ask those authors of treatises on physiology who desire to separate the study of intellect from that of matter, what they propose doing with a treatise purely on metaphysics? Let us suppose that they have prepared it with all the perfection which they could desire; if they have left it separated, in their work, from the physiological part, it will be of no use to this science; if they undertake to apply what they have said to this latter, they cannot avoid bringing the organs into play at each intellectual phenomenon. In fine, all their declamations about the moral being independent of the physical nature, all their mouthings against physicians *who are in the practice of only looking at the organs,* all the imputations of materialism and of grossness of thought, are reduced to this simple proposition, repeated to weariness for so many ages: *we cannot conceive how the movements of matter can give rise to thought;* a proposition which we are so far from disputing with them, that we in our turn cannot refrain from expressing our astonishment that the movements of matter can give rise to the construction of a bird's nest, a spider's web, the formation of the cells of a honeycomb, &c.

Let it be asserted that the laws of composition can be distinguished from the organs; that is conceivable, since these latter are formed by them; but to add that these laws pre-exist in matter, is what we do not and never can know. Because the organs are formed by these laws, we cannot conclude that the latter can exist without forming the organs. We have no means of conceiving of them in a state of inaction. If we isolate the laws of composition, it is to aid us in the study of their phenomena; but if we desire to make them pre-exist or give them an after-existence, it will be by the aid of comparisons, none of which can be accurate in a question like the present. But this is not the place to engage in such a discussion. Let physiologists maintain that thought may be conceived of as different from its organs, we shall still be able to un-

of the phenomena,—the word power being an abstract idea, by which we mean the unknown cause of the phenomena; we may then make use of the words, physical power and chemical power. This latter will be divisible into the chemical power of inert bodies, and into the chemical power of organized bodies. For ourselves, we prefer employing the term laws, which does not force us to go back to the unknown. The vital principle of Barthez will include vital chemistry, contractility, and sensibility, which last is the perception of the second; but we must beware of imitating this author in his creation of a number of secondary powers, which are nothing else but chemical and vital laws producing the phenomena of life.

As we inquired into the vital laws at the commencement of this work, it would be useless to revert to them: we only recalled them to notice in order the better to isolate the laws of vital or organic chemistry; and of this therefore we now propose treating.

The organic chemistry of man constitutes him such as we see him. A small mass of fecund animal matter being given, this has the property of attracting the nutritive materials which it obtains in the uterus, and of repelling those which are useless to it; and the immediate phenomenon is the composition of organs. The rudiments of these latter existed from the moment of conception, but they are only developed successively, and after a certain order. which we shall examine when treating of generation.

Organic chemistry persists after birth, and even acquires a new extension. In the embryo, it is limited to the composition of the organs, the materials for which were furnished by the mother. Immediately after birth, the organs which it had prepared for acting on external bodies begin to go into exercise, and new chemical phenomena are manifested: the lungs act on the air, the digestive canal on the food; and many new secretions are brought about. Still, however, the composition and decomposition of the body continue; the former is at first predominant, both are then for a while

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derstand them, for thought is an abstraction deduced from the observation of man thinking; but if they add that the thought of a man exists prior to and independently of his organs, they no longer speak as physiologists, but as complete metaphysicians, or theologians, and as such we shall forbear to pass judgment on them, as we are mere physiologists. We respect the theologians who in following the revelation treat of religious metaphysics, but we must tell physicians who would speak their language, that this kind of study adds nothing to the science which they cultivate, and that it would be misplaced in a treatise on the relations between the moral and physical nature of man.

equipoised, and finally the latter takes the lead, and vital chemistry disappears, to yield up the body to general chemistry.

Let us inquire into the most remarkable circumstances of two phenomena so opposed to each other, though in reality they are the result of the one single law.

The composition of organs is accomplished by means of the particles of the mobile animal matter. This cannot be employed for the purpose, so long as it circulates in vessels constituting columns of varying size. It must be divided to that degree as no longer to traverse the tissues, except particle by particle, which cannot take place until it shall have completely gone out of the blood-vessels. It is then by passing between the fibres, where the fluids are restrained by the laws of affinity from being diffused outwardly, that those of their molecules, necessary to each of the fibres, are fixed in these latter and become an integral part of them, either to serve for their growth or to take the place of the molecules that have just been detached from them, and which are carried off and conducted back to the venous system, to be afterwards evacuated by the depurators; as we have explained when speaking of the functions of those organs.(V) Thus, composition and decomposition are accomplished at the same time, and have nothing in common with contractility and sensibility; these latter are then but the means of carrying nutritive matter into the interior of the tissues, and it is the play of vital affinities which fixes it in them by detaching the old molecules. Now, such as described is the phenomenon of nutrition, which we have thought proper to designate by the term vital or organic chemistry.

But this is not all; there are limits to the composition and growth of the organs. Each of them must be developed according to fixed directions, and after a certain form and degree of consistence, and a particular manner of reflecting the luminous rays, when it is exposed to the light. Well then, all these conditions are fulfilled by the kind of vital affinities which takes place in the relations of the fluids with the solids; all, therefore, is, on final analysis, only the work of those laws which we designate under the title of organic or vital chemistry.

Organic chemistry composes bodies both in length and thickness, but it never decomposes them except in thickness, a fact demonstrated by disease and senile marasmus. It is a circumstance worthy of remark, that whatever be the emaciation of a phthisical patient or one labouring under diarrhœa, or a subject exhausted by chronic inflammation, we never meet with a solution of continuity in a

fibre, except in the seats of inflammation; the muscles are reduced to very minute bands, but they preserve all their fibres without any solution of continuity. It is the same case with the other tissues; the shortenings which may be observed are pure and simple contraction of the fibres, which being no longer stretched either by the interposition of calcareous phosphate, as in rickets, or by the presence of fluids, are condensed and present less bulk in every sense. The same observation may be made in senile marasmus; if it be solely the effect of age, we do not meet with any solution of continuity.

This admirable law may be considered as the safeguard of the existence of animals. If decomposition had gone on in every direction, the slightest indisposition would have interrupted the continuity of the organs; and the contractility of fibre, by widening the space between the extremities, would have necessitated cicatrizations so as to have prevented a complete restoration of strength. What would it have been in the case in which the body is brought to the state of marasmus? Never could an animal have recovered from a disease of even little intensity.

Whenever organic chemistry has composed the organs, it deposits the residue of nutrition in the interstices; if a derangement comes on in the animal economy, by which the sum of the nutritive materials is diminished, this power begins by resuming those which it had extravasated, and seems only to attack the tissues in their thickness after having exhausted this reserve. Does not this fact lead us to believe that the thickness of the tissues solely depends on an animal matter interposed between the fibres, which in a measure is but attached to and does not constitute part of these latter? After all, nothing is more difficult to solve than this question, because we have no means of isolating the fibre of a healthy man from all the fluids surrounding it. It may be, indeed, that the matters of which we speak form an integral part of the fibre, and that they are detached from its circumference in decomposition by marasmus; but under whatever light we may view this subject, it must always be conceded that there is in each fibre a central base, which normal decomposition can never attack.

The decomposition which I call abnormal is that produced by inflammation and its numerous varieties;—of these we shall speak when treating of the diseases of nutrition.

The composition of the organs being the grand phenomenon of life, the others must be, at least in a great measure, subordinate to it. Whenever the composition is rapid in all parts of the body, as

happens during the period of growth, and in very rapid convalescence, the assimilating chemistry of the digestive passages, which is intimately allied to that of the composition of the organs, as a phenomenon of the same order, is equally rapid; digestion is prompt, and the desire for food is felt with more than usual frequency. Hence an association, of which the stomach is the medium. In fact, this viscus exercises a great influence over the intellectual faculties that are to determine the movements of locomotion for the gratification of these wants; there is therefore an uninterrupted chain, from the molecular movements of organic chemistry on to the phenomena of intellect and instinct.

It is this union which constitutes unity in man, and in the animals with an organization most nearly resembling his. We doubtless shall never be able to conceive what relation can subsist, between the internal movement which composes and decomposes the solids, or which changes the form of the fluids, and that which assimilates foreign bodies; between these movements and the stimulation of the nervoso-vascular expansions of the membranes of relation; between this stimulation and the perception of a want; between this perception always accompanied by the exercise of the intellectual faculties, and the cerebral influence over the nerves of locomotion and the viscera; finally, between this last influence and the contraction of the muscular fibre: yet we distinguish very well all these phenomena, and are sensible that one is not the same as another. We vainly refer them to what we call life, or, if it be preferred, vital power; still it is not less certain that the physiologist has need of specific terms to express them, and I think that he may make use of them without subjecting himself to the charge of ontology: he will recognize then, in the living body, perception, innervation, contraction of fibre, and will see in these the evident effects of stimulation; but that will not prevent his understanding that the composition of the organs and the transformation of fluids constitute a process which cannot be confounded with the preceding; to it he will attach the name of organic chemistry, and the word life will express the combination of these phenomena.

Section I.—*In what manner Nutrition becomes a Cause of Disease.*

It is sufficient for the solution of this question, to call to mind the chain of actions of which we have just given a sketch. Nutrition, which consists, as we all know, in the composition and decomposition of the organs, is uninterruptedly exerted; but it is neces-

sarily influenced and modified by all the stimulations imparted to the living body. Let us engage in the details of this important fact, first observing what makes composition predominate, and then inquiring into what agencies render decomposition more potent, and what diseases thence result.

The most common cause of the excess of nutrition is incontestibly an excessive alimentation. The stomach, over-irritated by nutritive materials in too great abundance, assimilates beyond the wants of the organs: the first result of this increase of action is polysarcia; the second is plethora; the third is hæmorrhage; after which comes inflammation, which arises in the most irritable part. The stomach will, in consequence, be the most frequently attacked: but this may react upon another organ, the brain for instance; and the irritation having become predominant in this part, blood will be invited to it, and a host of disorders thence arise. We know also that the super-excitation of the stomach and duodenum brings with it that of the liver. I will not dilate on all the diseases that might proceed from excess of assimilation, having pointed them out while speaking of digestion and circulation: I will only remark that, in early life, and in what is called a scrofulous habit, the plethora is more lymphatic than sanguineous; which singularly favours the coming on of sub-inflammation, that always breaks out in the most irritated parts, as if to give a flat contradiction to those authors who can see nothing more in this than a relative predominance of debility.

Muscular exercise likewise augments nutrition, which is especially active in the muscles themselves: this is not, it is true, a cause of disease, but, as the stomach acquires by exercise a considerable assimilating power, and as it loses it with great difficulty, when rest follows labour, nutrition operates to the benefit of the adipose tissues and the blood-vessels, whence result polysarcia and plethora, together with all the consequences of these two states. We constantly observe this march of things in men who abandon themselves to idleness, after having been habituated for a length of time to fatiguing exercise. This is one among those causes that most effectually lay the foundation for inflammatory diseases at a more advanced age.

Cold gives more energy to composition than decomposition, either because the stomach, being less excitable, supports and assimilates a greater quantity of aliments, or because cutaneous elimination is of less amount. If muscular exercise be used in cold weather, the individual acquires the greatest volume and bodily strength

of which he is susceptible; but if he be inactive and exposed to cold, the excess of nutrition is only evinced in the fulness of the fat and blood: hence plethora and polysarcia; sanguineous, lymphatic, and mucous accumulations in the viscera, are the effects of this over-abundant nutrition. But we must observe, that in this state man supports very well those stimuli that excite the secretions. And hence the extravagant fashion for purgatives in cold countries.

Whenever one organ is more strongly irritated than the others, it acquires an excess of nutrition, becomes hypertrophied, and exposed to inflammation. This last process is itself a powerful cause of hypertrophy. Inflammation, in fact, always begins by increasing the vitality and volume of the tissues attacked by it. I have frequently had occasion to open the bodies of those who had sunk under the first period of a phlegmonous phlegmasia, and I always found a considerable increase of fat in the part affected, and in its immediate vicinity. It is in this way that a slight attack of gastritis gives rise to collections of fat in the omentum and mesentery, and produces a remarkable projection of the abdomen, which, joined to freshness of complexion, gives an idea of strength and health; whereas it is often only the prelude to the most dreadful inflammatory diseases. If the excess of nutrition be directed on the thoracic cavity, the lungs, overloaded with blood and unable to expand, become diseased; the heart is in a state of hypertrophy, and the dyspnœa, which often assumes the name of asthma, is the first effect of this pathological state.

Hyper-nutrition of the brain gives rise, in early life, to an excessive volume of the head, a state often, as I have already said, converted into hydrocephalus; but in more advanced life, this plethora leads to encephalites, madness, and apoplexy. The morbid fulness often shows itself in the throat, especially in youthful age, and thereby predisposes to, and keeps up very violent and often extremely untractable anginas.

Irritation, when acting more particularly on the nerves, produces hypertrophy of them, either in their trunks and branches, or in the ganglions, or, finally, their sensitive expansions. Sensibility and mobility are at this time excessive, and inflammation, at any rate of a chronic kind, is the inevitable consequence of this state.

If originating in the tissues in which lymph abounds, the irritation causes in them a hypertrophy which advances more slowly than that produced by sanguineous inflammation, but which carries

to a much greater extent the volume and deterioration of the irritated parts. Nutrition is depraved, and creates in them abnormal tissues, which finally render the organs hotter and more sanguineous, until, sanguineous becoming joined to sub-inflammation, the cancerous disorganization is on the point of appearing. There are, however, a great many cases, in which the abnormal or morbid mode of nutrition of the lymphatic tissues serves to harden them, and keep away the blood, by obliterating the vessels by which they are supplied; then the part becomes fibrous, cartilaginous, or osseous, and it is impossible for the cancerous alteration to take place.

There is another variety of abnormal hypertrophy which generates fungous growths, called likewise vegetations, and which are of two kinds: some hard but sanguineous, may pass into the cancerous state; others soft, and rather serous than lymphatic, grow without bounds, and display no tendency to be carcinomatous; sometimes even they are seen to dry, wither up, and come away of themselves. The skin, especially when ulcerated, and the membranes of relation, are their most usual seat.

Those red and fungous tissues, so rich in blood-vessels and known under the name of bloody tumours, fungous hæmatodes, anomalous tumours, cancroides, and improperly compared to the natural erectile tissues, as of the cavernous bodies, the iris, the nipple, &c. are also the effects of a pathological hypertrophy.

Cysts or sacs, whatever be the matter they contain, are hypertrophies; the primary nucleus of which is an irritated cell or areola. Those that contain blood are formed round a clot, produced by an effusion, the serous portion of which has been absorbed. The cellular tissue, irritated by the presence of foreign bodies, is the part which is organized into cysts; it vegetates, and is on its inner surface converted into a kind of tissue analogous to that of the serous membranes. In general all foreign bodies inclosed in our organs, such as balls, are capable of producing this effect; it is sufficient that they be not too stimulating to give rise to a suppurative inflammation round them.

If we cannot entirely account for all these varieties of abnormal nutrition, observation leads us at least to refer them to an irritation which invites the fluids to the affected part, and deteriorates in various ways the organic chemistry.

The modifications constituting a predominance of decomposition, and consequent diminution of nutrition in the living body,

are all those which we have seen capable of augmenting growth, and others which are entirely of an opposite nature. The first and most powerful of these last causes is the defect of nutritive materials. This fact is so evident, that it would be idle for us to stop at it; but we cannot forbear speaking of the influence which food of a bad quality exercises on the decomposition of the solids and fluids. It is already seen that we allude to scurvy.

This affection, characterized by sanguineous extravasations, either externally, (as in hæmorrhagies,) or in the interior of the tissues, as the skin, and cellular net-work, (as ecchymoses, vibices,) presents at the same time to the observer, fragility of the muscular fibre, which easily tears when it is forced to contract with energy, and engorgements in the parenchymæ eminently venous such as the liver and spleen. We, moreover, meet with a languid absorption, producing dropsy and inflammations, which promptly go on to suppuration, hæmorrhagies, and gangrene.

These phenomena have been attributed by physicians to the extreme diminution of vital power. There is, without doubt, weakness in scurvy; but this asthenia is different from that of other diseases, for death will follow exhaustion from a host of chronic affections, without any sign of scurvy. I have examined these diseases attentively, in order to have an opinion based on something solid; and I have always remarked, that the patients who sink under gastrites, whether acute, (adynamic fevers,*) or chronic, constantly presented some traces of scorbutic decomposition. This observation leads me to believe that the primary seat of scurvy is in the mucous surface of the digestive passages, whether the disease proceeds from substances of difficult assimilation, such as putrid meat, stagnant water, aliments of either kingdom altered by water and salt, or moulded, or whether it is the effect of a chronic inflammation; in other words, that this latter never occasions it without being at least complicated with an inflammation of the above surface.

There are cases in which moisture, sadness, and darkness are taxed with being causes of scurvy; but do they ever accomplish it without having previously interested the mucous tissue of the abdomen? I do not believe it; and I now think, that if we observe so much weakness and fragility in the blood-vessels, serous tissues, and muscles, it is because a particular mode of irritation had been previously established in the internal membrane of the digestive

* Writers long ago pointed out the analogy between the putrid fever and scurvy.

canal, by which assimilation was rendered imperfect, especially as regards the formation of gelatin and fibrin. This modification is frequently repeated in the membrane covering the gums, which is inflamed, ulcerated, and mortifies; but this inflammation may be wanting, or, when present, may be the immediate product of cold and saline food, and the bad state of the membrane of the mouth then renders its disorganization easier.

In fine, I am inclined to believe, that in scurvy, whatever may be its cause, there is, 1. an irritation of the internal membrane of the digestive canal; 2. an imperfect assimilation of the elements, especially of fibrin and gelatin, either in the tissues formed out of them, or in the blood which directs them to different parts of the body. Now this radical vice of nutrition cannot exist without a diminished cohesion of the fibre, and this diminution seems to me to explain why contractility is languid; why the vessels rupture and allow the escape of their fluids; why the muscular fibre is so fragile that it is often torn in the efforts of contraction; and, finally, why the tissues in scorbutic persons are so easily disorganized in phlegmonous inflammation.

Then come excessive evacuations, either of blood or secreted fluids; and we know that, when not traumatic, they are constantly dependent on irritation.

Exercise, by favouring composition, may also, as an exciter beyond bounds of the action of the eliminating organs, especially of the skin, become a powerful cause of decomposition and marasmus.

The same may be said of all the agents susceptible of unduly exciting the secretory action. Coition in excess hastens decomposition, less by the evacuation of semen, which is but trifling, than by the increase of nervous activity and cutaneous exhalation. The effect is remarkable. I have seen it in Spain in the studs, in the case of stallions which were abused, because the number was diminished by military requisitions. I have seen them become in less than a fortnight extraordinarily thin, though they had a great appetite, and care was taken to exempt them from any other kind of fatigue.

In attributing this emaciation to an exaltation of sensibility, I do not give an explanation wanting the support of analogy; we know that all strong passions and even frequent convulsions give a predominance to decomposition; persons who have much business and care become sensibly thinner under the influence of these causes, even though they make use of an abundant and substantial nourish-

ment, whilst those who leave off business and lead a careless and easy life never fail to become fat. I have frequently observed, that repeated convulsions induced emaciation in a very short time, and that, when made to cease, colour and flesh were at the same time restored to such persons. Differences of this nature are more especially sensible in subjects of a nervous temperament; for there are some so insensible and cold, that nothing short of a famine or inflammatory disease can endanger their nutrition. Atmospherical heat gives dominant power to decomposition, by the double influence of the exaltation of sensibility, and the increase of cutaneous transpiration; but the wasting away is more particularly remarkable in the cellular tissue; for it is an observed fact, that exercise may support to a very great extent the nutrition of the muscles under a burning sky, as we find in the Arabs of the desert.

Among the causes hastening the decomposition of the organs, inflammation must not be overlooked; though its first effect is, as we have seen, to increase the nutrition of the part which it attacks, its secondary consequence is, in addition, constantly to bring on its softening and a purulent collection either with or without ulceration. This cause is even the only one, among those of a spontaneous nature, that can break the continuity of the tissues: besides this, inflammation gives rise to emaciation, both by the obstacle which it sympathetically opposes to the assimilating action of the stomach, and by the state of spasm or erethism which it keeps up, as also by the evacuations which it causes, when carried to the degree that produces fever.

Sub-inflammation has but little agency on general nutrition, unless it be complicated with inflammation and erethism, or interest the organs that preside over assimilation and hæmatosis.

Our readers doubtless cannot have forgotten, that, when classing scrofula with irritative diseases, we assigned to it as a primary cause, the languor of the assimilating power, or rather of the composition of the tissues; it would consequently be useless to recur to this point.

Does there exist any instance of debility of nutrition, or predominance of decomposition, that can be regarded as foreign to irritation viewed either as cause or effect? My opinion on the subject is this.

The languor of the power of composition may depend on a defect of oxygen, caloric, or light, or on the effect of poisons, or of deleterious gases; it is in these cases either acute or chronic. In the first

it is promptly mortal, and may take place without irritation; in the second it is always followed by this state, so that the sedative indications are simultaneously presented with those of excitation: I mean to say, that if on one side the system has need of a stimulus adapted to nutrition, such as oxygen, caloric, and light, it exacts at the same time the withholding of other agents of excitation, and even sometimes the bringing on of evacuations, either immediate or revulsive, of some fluids, such as blood, or the secretion of an artificial phlegmasia. I only know of senile marasmus which can neither be the cause nor the effect of irritation, and which depends solely on the weakness of vital chemistry; but it is well for us to be apprised that this marasmus must not be confounded with that seen in certain old persons, who are far from having attained the natural limits of their existence, and who are only thus exhausted by a visceral inflammation, kept up by the improper use of stimuli.

I have given in the *Annales*, vol. v. p. 545, the case of a caries and softening of the cervical vertebræ, observed in a woman attacked with cancer of the breast. I do not believe that we can look on the decomposition of these bones as independent of irritation, which in this case was present in the mammary glands, and might have been repeated in other tissues. I do not therefore deem it necessary to insist more on this point.

CHAPTER XIII.

OF GENERATION IN GENERAL.

Generation, or reproduction, is performed in many ways in the series of living bodies. The more complex their organization, the more difficult is the execution of this function. It is known to all that the limbs of a polypus detached from its trunk are converted into polypi; and the same is the case with a great number of plants that are reproduced by grafting; but in the larger portion of animated creatures, reproduction is effected by means of an organ *ad hoc*, for the purpose of forming the germs. It is not less remarkable that these organs are of two kinds; the one male, and the other female, which constitute the sexes. In many species of animals and vegetables, the two sexes are united in the same individual; but soon, and in proportion as her work is perfected, nature shuns

this union, and even goes so far as to give to each sex a peculiar constitution in relation with the generating organs allotted to it; whence it results, that the sexual differences are so much the more definite as animals are more elevated in the zoological scale.

The sexual organs of the male give—those of the female receive. We know that these latter retain and develope, but we are as yet far from determining with precision what is given by the first. Until the new being is organized, we see nothing but free animal matter. This is secreted, or, more properly, fashioned by means of vital chemistry, in the generating organs of the two sexes; in whom there is therefore respectively male animal matter, and female animal matter. But this double nature is sterile in the organs of both sexes, so long as they are not brought together in a certain manner.

We shall, therefore, have to study, in the function of generation, 1. the sexual organs of the male and the female; 2. the causes producing and the circumstances attending their union, whence results the mixture, or being placed in relation with each other, of the reproductive animal matters; 3. the preservation and growth of the new being, in the sexual organs of the mother; 4. its issue, or the ejectment of the fœtus; 5. and finally, the continuation of its growth, so long as the mother is to furnish it with nutritive matter. All these points are so much the more important, as each of them is connected with the etiology of numerous morbid affections.

Section I.—*A summary Description of the Genital Organs of Man and Woman.*

In man we meet with the organs that secrete the semen; those which serve for its deposit; and finally those which convey it outwardly.

1. The first are the *testicles*, glandular organs to the number of two, lodged in the scrotum, of an ovid form, and reddish appearance, soft, and as it were pulpy, a result seemingly produced by the interlacing of numerous and in degree filamentous ramifications of the spermatic ducts or secreting vessels. Their more immediate envelope is a fibrous membrane called *albuginea* or *peritestis*, of an opaque white, analogous to the sclerotica, though less thick and sending into the interior of the parenchyma, which it covers, filiform or flattened prolongations that divide the testicle into several lobes, separated by partitions. They are united towards the superior part of this organ, where is found the *corpus Highmorianum*,

sinus of the seminal vessels, (Chaussier,) an oblong prominence which is traversed obliquely by, or in which are discharged, the principal trunks of the seminal vessels which pass to the *epididymis*.

This is a small oblong body, vermiform, swelled at its ends, and resting on the upper border of the testicle, to which it is only adherent by its *head*, or most swelled extremity, and by its *tail*, or smaller end, while its body, still smaller than the tail, seems free. The epididymis is a canal formed by the reunion of vessels, which, after having traversed the corpus Highmorianum, meet in the head of the part above spoken of, are next continued into its body, and terminate in its tail.

From this last arises the vas deferens, which leaves the testicle and unites itself to the spermatic artery and vein, and to lymphatic vessels and nerves, to form the *spermatic cord*. This rises vertically towards the abdominal ring, in which it is engaged, and on going out from which the blood-vessels and lymphatics, as well as the nerves forming the cord, pass on to their respective trunks. As to the vas deferens, after having left the cord and passed on each side through the abdominal passage of the small pelvis or inferior strait, it goes to the sides of the bladder, passes under the inferior region of this organ, nearly meets its fellow, and finally terminates in the *vesiculæ seminales*.

The testicles and epididymis are enveloped in several membranes; viz. from within outwardly, the *fibrous coat*, forming two small sacs; the *tunica vaginalis*, a serous membrane, which is merely a portion of the peritoneum: it encloses each testicle, without however containing it in its cavity; the erythroid coat, or cremaster muscle, formed by fibres of the ilio-abdominal muscle, and the *dartos*—cellulo-filamentous membranes, which are in apposition at the internal part, and thus separate the two testicles from each other: finally the *scrotum*, or cutaneous envelope, which is only a prolongation of the skin, presenting on the median line a prominent surface called *raphe*, and corresponding to the apposition of the dartos.

The testicles receive the spermatic arteries, and give origin to veins of the same name: we discover in them lymphatic vessels, but as yet we have not been able to trace into their substance any nervous filament belonging to the cerebro-spinal apparatus,—which would restrict their supply to the splanchnic nerves that reach them in company with the spermatic arteries.

II. The organs in which is deposited the semen are the *vesiculæ seminales*, membranous sacs, two in number, situated on the lower part of the bladder, before the insertion of the ureters,—in figure irregularly conoid, knotted at their external surface, and terminating by two very short and small canals, which open into the vasa deferentia, and at the same time give origin to the *ducti ejaculatores*, which open into the urethra on the lateral parts of the *verumontanum.*

III. Finally, the excretory organs of the semen and their appendages, are the urethra, the corpora cavernosa, prostate glands, and the glands of Cowper.

The urethra, a membranous canal in length from nine to twelve inches, extending from the neck of the bladder to the end of the penis, presents in the direction of its length three distinct portions, 1. the *prostatic*, embraced by the prostate gland and nearest to the bladder; 2. the *membranous*, from eight to ten lines in length, placed beneath the symphysis pubis; 3. the *spongy*, and much the longest, beginning below by an enlargement called *bulb*, and terminated above by another expansion, which has received the name of *glans*.

The canal of the urethra is situated in a kind of channel, formed below by the *corpora cavernosa.* These truly constitute but one body, the two posterior roots of which are attached to the internal border of the rami of the ischia and pubis, whilst the anterior extremity represents a truncated cone united at the base of the glans.

A mucous membrane lines the interior of the urethra, and forms, towards the neck of the bladder, on the medium line and inferiorly, an oblong projection called *verumontanum.* A cellular membrane is applied to the exterior of the urethra in its two first portions, and the third is formed of a spongy tissue.

The appendages of the excreting organ are the *prostate* and the *glands of Cowper.*

The first encloses the urethra at its origin; it is tolerably voluminous, formed of an assemblage of mucous follicles which give rise to excretory ducts, the orifices of which are at the surface of the *verumontanum.*

The *glands of Cowper* are two small bodies placed beneath the urethra, and before the prostate; they give origin to two excretory ducts, the orifices of which are seen before the *verumontanum.*

In the female we meet with the organs of copulation, those of

conception, and of gestation, and those for the nourishment of the child.

I. The first are the *vulva and its appendages.* We call *vulva* the combination of the external parts of generation; it includes 1. the *mons veneris,* a fatty, rounded eminence, covered with hair, and placed before the pubis; 2. the *labiæ,* membranous folds occupying the lateral and upper parts of the vulva; 3. the *nymphæ,* membranous ridges situated at the internal portion of the great labiæ, and more or less elongated; 4. the *clitoris,* an erectile tubercle of a structure analogous to that of the penis, and hid by the labiæ; 5. the *meatus urinarius,* or external orifice of the urethra, which canal is much shorter and wider that that of the male; 6. and lastly, the *hymen,* or the *carunculæ myrtiformes* the remains of this membrane, which more or less completely closed the entrance of the vagina before *defloration.*

The *vagina,* or vulvo-uterine duct, is a membranous cylindroid canal, placed in the interior of the small pelvis or inferior strait, opening to the vulva on one side, and embracing the neck of the uterus on the other. It is lined by a mucous membrane which is supported by a spongy tissue.

II. The organs of conception and gestation, are the *ovaries* and the *uterus* with its appendages.

The *uterus* or womb, a pyriform organ destined to lodge the fœtus, is situated between the vagina and the ovaries, communicating with the first by its *neck,* and with the latter by two canals which go out, one on each side the superior edge of its body, and which are called *Fallopian tubes.* These canals, contained in folds of the peritoneum, called *ligamenta lata* pass on each side to the ovaries, to which they only adhere by one of the fringes which terminate their external extremity called *fimbriæ.*

The *ovaries* are two ovoid bodies less voluminous than the testicles, and contained in the substance of the *ligamenta lata:* they are attached on one side to the uterus by a small ligamentous cord called *ligament of the ovary,* and on the other to the *Fallopian tubes* by one of the processes of the *fimbriæ.*

The uterus is lined by a mucous membrane; but the proper tissue of the organ is not yet perfectly known: comparative anatomy may however lead to the belief of its muscularity, since in the large quadrupeds muscular fibres are very evident. The *Fallopian tubes* are likewise lined by a mucous membrane, external to which we see an erectile spongy tissue like that of the urethra. As to the

ovaries, they are enveloped in a cellulo-filamentous membrane sending a great number of prolongations into the interior of their tissue. This is composed of cellular lobes, each containing a small transparent vesicle of the size of a millet seed. The uterus, the Fallopian tubes, and ovaries, receive nerves from the great sympathetic and spinal cords; they are also supplied with arteries, veins, and lymphatic vessels.

III. Finally, the organs for the alimentation of the infant are the *mammæ*, glandular bodies of a hemispherical form, to the number of two, situated on the lateral and anterior parts of the chest, and presenting towards the centre a roseate or brownish circle called *areola*, surmounted by a conoid tubercle named *nipple*, on the surface of which open the vessels called *galactophori*.

Independently of the skin which covers them, and which, agreeably to a remark of Bichat, on approaching the nipple, bears a resemblance to the mucous membrane; and besides the layer of fatty cellular tissue of varying thickness beneath the skin, the mammæ are essentially composed of a voluminous gland divided into lobes of different sizes, these lobes into lobuli, acini, &c.: the glandular acini give rise to ducts called *galactophorous* or *lactiferous*, which unite in a fasciculus terminating at the nipple. The mammæ receive arteries, and give origin to veins and lymphatic vessels; the nerves observed in them come from the intercostal and the brachial plexus.

Section II.—*Physiological Action of the Genital Organs.*

Of the Union of the Sexes.—This union is founded on the developement of the passion of love, and this latter again on the structure of the genital organs. Let us first examine these desires in man.

The semen is the principal exciter of venereal desires; but in general we may say that all the stimulations of the genital organs which do not pass the limits of the normal state, give rise to pleasure, and may excite desire. Nothing is better ascertained than this, since children of a tender age, and eunuchs, are susceptible of them. This phenomenon is in some measure an excess of precaution on the part of nature, tending to give more force to the inclination which leads man to the reproduction of his species. It is worthy the attention of the physician, since it may become a cause of disease. The greater number of our wants admit, however, the like extension; as I have already had occasion to remark.

After all, real desire, that avowed by nature, is the effect of the presence of semen accumulated in the vesiculæ seminales. The stimulation exercised on the sensitive surface, or on the mucous membrane of this reservoir, is what renders the desire more lively and better defined, and which excites most imperiously to copulation. It would be, however, an error, to suppose that the semen invites men to coition, by the stimulation alone of the vesiculæ seminales; that effected in the epididymis, and even in all the seminal ducts, must be taken into the account. There are even many animals which do not experience this irritation as an exciter, since they are deprived of vesiculæ seminales. These vesicles are only evidences of a more perfect organization, seldom met with but in animals the highest in the zoological scale. There is an evident reciprocity between the sensitive surfaces, which are in relation with the semen, and the brain, the organ of perception. In the normal series the first stimulation comes from these surfaces; the brain takes cognizance of it, and reacts by innervation on the genital organs. It is then that the erection is produced, the chief seat of which is in the corpora cavernosa, and not in the seminal surfaces. I say the principal seat, for the erection is not limited to the penis; it takes place at the same time in the whole genital apparatus; the testicles and epididymis are hardened; and though the erection of the vesicles be not appreciable, we are led by induction to admit it. The cremaster is contracted, the scrotum and all the cellular tissue undergo a very sensible retraction; finally, the spongy tissue of the urethra, and even its mucous membrane, participate in the erection, and all these with so much the more energy, as the semen contained in the seminal vessels is more abundant and more concentrated.

When the erection is accompanied with strong desires, the stimulation is general throughout all the organs liberally supplied with nerves and vessels. A vivid sensation is experienced at the epigastrium; the mouth is heated, the throat parched, and the secretion of saliva altered; the heart palpitates; the eyes sparkle, respiration is accelerated, the vital erection of the brain is evinced in the exaltation of ideas, flush of the face, irascibility, &c.; the skin is corrugated, the muscles are stretched, and agreeable sensations are experienced in all the sensitive parts of the body.

What is the composition of this humour which produces such singular phenomena? Alas! nothing extraordinary; albumen, a little gelatin, some acids and salts—articles usually found in all the animal fluids. The semen, it is true, is remarkable for a very de-

cided odour—such as we meet with in some of the grains of the cerealia; it is the odour of the pollen of plants, and is particularly distinct in the flower of the horse-chesnut; one might thence be tempted to suppose it connected with the process of reproduction; but when we find it in the orchis root, in the mass of the brain, and in recent bones, which when sawed exhale it in a very decided manner, we abandon this idea, and are compelled to grant that the aroma in question is a principle common to various parts of organized beings; a principle, the office of which is no more known to us than that of the aromas of musk, or of the rose, or of castor, or urine, and all those peculiar to each species of animal and plant. However this may be, the fecundating property of the semen, and its quantity and strength, are indicated by those of its odour.

The semen is secreted in the testicles by a mechanism which was formerly thought to be well known. The spermatic artery brings, we were told, the materials for this fluid. The secreting vessels which are detached from small ramifications, select these materials, as soon as they are presented to their orifices; they then collect and combine them, in order therefrom to form the semen; and while this latter goes through all their tortuous folds, it is still farther strained and purified by absorption, which takes from it whatever foreign elements it might have had. This elaboration is continued in the epididymis, the vasa deferentia, and above all is most marked in the vesiculæ seminales. It is there that the semen, by its detention, becomes more pure, thick, and penetrating. It would even acquire too high a degree of acridness, did not the absorbents, after having deprived it of all that was heterogeneous, also carry it off: or if dreams, in defect of coition, did not procure its spontaneous evacuation.

The greater number of these assertions are, to our minds, well-determined facts; we would only venture to call in doubt the received mode of secretion. The seminal ducts are perhaps only the excretors and not the true secretors of the semen, in the formation of which it seems to us that we ought to admit something else besides a simple separation of nutritive materials floating in the circulation. But, as I have explained myself elsewhere on this subject, I shall not recur to it; I would only request anatomists to study more attentively the structure of the testicular parenchyma.

In the female, the desire depends entirely on the normal excita-

tion of the genital organs; its seat is in the clitoris and vagina; but it seems that the aptitude to true pleasure depends on the influence exercised on these parts by the adequate developement of the ovaries.

We shall here give some general facts relative to the desire, and which we think fit to point out, as they will find their application in pathology. If the venereal appetite is the more decided, (as granted by every physiologist,) in proportion as the semen is more abundant and charged with prolific principles, it must follow that the desire will be stronger in man than in woman, who has no stimulus analogous to his. In fact, man desires because he has in himself a material cause of stimulation, which irritates him the more the longer its expulsion is delayed. Woman, deprived of this stimulus, only desires because of an irritation much less intense in the genital apparatus. The source of the pleasure is in man himself, the source of the woman's enjoyment is in man. Hence a prodigious difference between the two sexes; a difference affecting all their actions, and influencing the part which each has to play in the social state. Woman, wanting in the most powerful stimulus, only has desire in general in proportion to the eagerness of man to gratify it; nothing is easier than to calm her erotism, unless it has already gone beyond the normal state, or that improper stimulations have raised the irritation of her organs to that degree which corresponds with the orgasm of female animals. It is because woman is not the slave of the want of this enjoyment, that she can, without suffering, forego it for such a length of time in order to suckle and direct the physical education of her children. Hence we never hear, even in cases of erotomania, of her forcing man to gratify her desires; she is contented, as the late Buisson observed, to win him by gestures and speech, but never does she undertake to subdue him by force.

It is to the want of semen, to the general constriction of the sexual organs, to the little blood which passes through those destined to copulation, (the vulva and vagina,) to the feeble innervation taking place in these tissues, that we must attribute the vagueness of the desires of a young and innocent virgin. The clitoris is here the only organ that can excite the others; but at this time it is very slightly developed. In general, there is strong desire only in women who have felt the stimulus of the approach of man. We do not find in them that inflammatory tumefaction of the vulva and vagina which constitutes the orgasm in the females among the brute

tribe; nature has not submitted them to that humiliating state, in which the female is forced to entreat, with loud cries, the carresses of the male.

We know the influence exercised by the imagination on these organs in the two sexes; it is such that any idea relating to love is necessarily accompanied with some slight degree of vital erection in the sexual organs.

All the signs of irritation, the picture of which we drew when speaking of erection, are greatly augmented during coition; and the emission brought about by the friction of the genital sensitive surface during the voluptuous junction, is its natural termination. Some reflections might well be made here on the effects of all friction exercised on the surfaces of relation; it will suffice for our present purpose, to say, that the kind of stimulation belonging to the sense of touch is one of the most energetic with which we are acquainted.

The emission takes place in man from the vesiculæ seminales, and, in animals deprived of these organs, from the seminal canals. The seminal liquor, brought forward by the oscillatory movement of the vesiculæ seminales and the excretory ducts of the testicles, arrives in the urethra near the verumontanum. So soon as the mucous membrane or the internal sense of this canal has felt the stimulation resulting from the presence of this fluid, the bulbo-cavernous muscles which on one side envelope the bulb of the urethra at the beginning of this canal, and on the other embrace the roots of the cavernous bodies, undergo convulsive contractions which are participated in by the ischio-cavernous muscles and the sphincter ani, and to each of which corresponds a jet of semen. The levator ani always partakes of this convulsive movement, in order to furnish a point of support to all the above-mentioned muscles; and their contractions are renewed as often as the excretory canals continue to furnish semen.

We may infer from this exposition, that the genital apparatus of man gives rise to numerous sympathies, of which some are local and others remote. The local ones observed are, 1st. of the gland and the entire skin of the penis, and scrotum, with the apparatus secreting and holding the semen; 2d. of the internal surfaces of this apparatus, and of the urethra, with the erectile tissues and ejaculator muscles. The remote sympathies depend on the lively stimulation which the brain, sensible of the irritation of the genital surfaces, internal as well as external, transmits to the nerves of relation; hence

some sympathies take place in the senses and muscles, and others in the viscera comprising those of generation.

In woman coition is attended with very nearly analogous effects; the local sympathies are, however, limited to the influence of the irritation of the vaginal mucous surface on the musculo-erectile tissue embracing the orifice of the canal, and on the Fallopian tubes, ovaries, and clitoris, which latter, in these cases, as well as in those in which it is first stimulated, reacts on the above tissues.

Though women do not secrete semen, yet coition often produces in them convulsive contractions of the vagina, which is thereby shortened and approximated to its axis, with the effect of an expulsion of a mucous fluid. This phenomenon appears to us merely the imitation of what takes place in man; it is not by any means necessary to conception, and must be considered as depending on the same law under which man has mammæ, though he be deprived of mammary glands, and woman a clitoris, though she has no need of it for generation, and does not expel by its means either semen or urine. These kinds of organs and acts, which to us seem useless, are only in relation to the species; they are the impress of that grand law which presides over the organization of all animals of the same class, and are attached to the extended views of general physiology and comparative anatomy, which we find developed in the works of M. Geoffroy St. Hilaire, Tiedemann, and others.

The stimulation of the vagina, produced by coitus, being, as we have said, communicated to the whole uterine apparatus, the Fallopian tubes are thrown into a state of erection, by which, of themselves, their fimbriæ are applied to, and embrace the ovaries. This is an indispensable preliminary for conception to take place; after which it is necessary that the semen thrown into the vaginal cavity, should pass the neck of the uterus, penetrate into the Fallopian tubes, and traverse them so as to reach the ovaries.* One of the last mentioned organs is adequate to bring about conception. Stimulated by the semen, it reddens and swells at the most yielding point; its investing membrane is ruptured, and gives issue to a drop of gelatino-albuminous matter, which the Fallopian tube, the fim-

* It is still a moot point in the physiology of generation, to ascertain the manner and agency by which the stimulus of the semen affects the ovaries. We have good reason to believe that it cannot in many cases be by the direct transmission and apposition of the semen to these bodies. The occasional occlusion of the os tincæ and yet conception taking place, forbids this supposition.—Trans

briæ of which are still applied to the ovary, takes up, absorbs, and conducts, by a kind of peristaltic movement, into the cavity of the uterus. This drop is nothing less than the embryo, or at least it is contained in it. But what takes place at the moment in which the semen is in contact with the surface of the ovary? Here begins the obscure, the inscrutable: we are all aware of the numerous systems proposed for explaining generation, all of which may, however, be reduced to the three following, now presented in a chronological series.

1. The mixture of the two seminal fluids, an opinion, the origin of which goes back as far as the ancient philosophers, and which is that adopted by Hippocrates and Galen; 2. the system of ova, which has the most numerous class of partizans; 3. the system of spermatic animalculæ, which only dates from the microscopical observations of Leuwenhoeck and Hartsoeker.

According to this latter belief, the male alone furnishes the embryo; his semen contains thousands of them, under the form of small animals, observable, we are told, by the aid of the microscope. The office of the female is restricted to the furnishing it with a lodging, which it finds in the vesicles of the ovaries; one of which is penetrated by the most vigorous of these animals, that afterwards grows and is developed like the larva of the fly in the gall-nut.

The system of the ovists is the precise counterpart of the one just stated: they maintain that the embryo exists ready formed in the ovaries; every female having a certain number of them, which would remain in a state of useless repose during life, did not the semen masculinum come to arouse them. As to the origin both of these animalculæ and the embryos of the ovaries, some believe that they were formed at the creation, and included one in the other in the first male or in the first female; others, that they were at that epoch dispersed at random through nature, and taken in together with the *ingesta* and *absorpta*, by the other organs, and by them finally deposited in those of generation.

The third opinion, which was supported by Buffon with all the eloquence he was known to possess, holds a medium between the two preceding ones: it admits in the woman a semen secreted by the ovaries, though not demonstrated by anatomical researches or experiments. This liquor flows, we are told, along the Fallopian tubes in the moment of coition, and is mixed with the *semen masculinum*. Each of these fluids contains particles extracted from

the individual who furnished them, and their combination round a supposed mould produces an embryo, male or female, according to the predominance of one or other of the parents.

I do not believe that we can seriously enlist ourselves as advocates of any of these three systems,—hypothetical as they all evidently are: even though we admit their being animals, we know of no demonstration of these microscopic corpuscules being truly men in miniature, doomed to live and die by myriads in the most abject degree of the zoological scale; since similar microscopical animals are found in vinegar, and a great number of vegetable infusions, which are not destined for generation. It is no less visionary to admit an embryo in each ovarian vesicle; first, because it is impossible to demonstrate any in it, and those who assert their having distinguished these things in the ovæ, or the unfecundated roe, have done nothing else but imagine a fiction, in order to give support to their opinion; and next, because this peculiar state of torpid existence, unsusceptible of any ulterior developement until the instant when the semen shall arrive and stimulate the ovary, is a gratuitous supposition, resembling that of the spermatic animalculæ, and a tale, the invention of which is unsupported by any fact. Finally, the mixture in the uterus of two seminal fluids, each containing molecules extracted from the bodies of the two sexes, and which are to be arranged round a pre-existing mould, is another fiction, the more inadmissible, inasmuch as the female semen has no existence, and as conception is not accomplished in the uterus.

What remains to us then as proved? 1. The existence in the ovaries of the female, of several small deposits of animal matter intended for generation; 2. the existence of another animal matter furnished by the testicles of the male, and destined for the same office as the former; of such a nature, moreover, as to exert a lively stimulation on the internal genital mucous surfaces, (internal genital senses,) of the two sexes; 3. the absolute necessity of the direct contact of this last matter with the surface of the ovary, or with the animal matter previously excreted from it.*

These conditions being fulfilled, fecundation takes place: it is in the human species, as in all other animals and vegetables, the work of organic chemistry; the necessary vital impulse having been given, that is to say, all the movements necessary to bring together

* Even though the *aura seminalis* fecundates, our position is not the less tenable: the emanation from the semen is still semen.

the two animal matters having been performed, the play of molecular affinities, directed by the unknown power which we call life, or vital power, accomplishes the rest; and to attempt to penetrate into its mysteries is to bewilder ourselves in darkness. Have we after all any clearer comprehension of the nutrition of a being already formed, than of the formation of a new being? Alas! we do not even know how to explain the formation of a cicatrix, or the composition of a humour, the principles of which were not pre-existing in the blood: still more, all the art of our chemists does not go so far as to imitate a single one of the animal or vegetable fluids, even though they think they have united together all the materials composing them. Why then should we find any thing more incomprehensible in generation than in other vital transformations?

Is conception effected at the moment of coition? I do not believe that there can be any doubt on this subject. Woman endowed with much sensibility distinguish very well the moment, which must be that in which the semen, having traversed the Fallopian tube, is brought in apposition with the predisposed ovary. It seems to us, moreover, that the perfect resemblance between two twins is a proof that they have been conceived at the same moment; for how believe in the possibility of two precisely equal vital impulses? We do not know whether the formation of two twins depends always on the simultaneous fecundation of the two ovaries; the gestation of three or even four children, shows, at least, that a single ovary may furnish several embryos.

The uterine cavity presents, according to experimenters no change until the ninteenth day after conception. During this interval the principal phenomena take place, it is said, in the ovary. The point touched by the semen undergoes a vital erection resembling inflammation; a vesicle is formed, which breaks, and the contained humour is absorbed by the tube, the fimbriæ of which had remained attached to the ovary from the moment of conception. This humour is nothing else but a small ovum, in which are contained the embryo with its cord and membrane; the opening of the vesicle giving issue to the fluid, leaves a yellowish point, somewhat resisting, which gradually disappears, and is called *corpus luteum*.

It is, then, towards, the nineteenth day, according to general opinion, that in woman the ovum arrives in the fundus of the uterine cavity. At this epoch the embryo, which it encloses like a true parasite, has gained sufficient strength to apply its nutritive

mouths to the surface within reach. It is now fixed in the uterine cavity, which combines all the conditions necessary to its developement. First, it determines, by the stimulation of its combined absorbing mouths, (placenta,) a vital erection, accompanied with heat, and afflux of fluids; in a word, a true shade of inflammation. The sensibility of the uterus does not seem to be at first augmented, but the stimulation of this organ cannot fail to be repeated in the other viscera. There are numerous grades of this influence, but we must here restrict ourselves to those which do not pass the normal state.

The uterus being now subjected to a continual stimulation which converts it into a centre of fluxion, ceases to be affected by the periodical stimulation which gave rise to the menstrual congestion and hæmorrhage. Some women are, however, an exception to this rule, especially in warm countries; but the hæmorrhagic congestion can, we are told, only take place at the neck of the uterus, since the internal surface, in connexion with the fœtus and its appendages, no longer communicates with the exterior. This principle recognized by authors must, however, be liable to exceptions; there are a great number of cases in which the blood, or else gases, escape from the cavity even of the uterus; superfœtations prove likewise that the opening of the two Fallopian tubes is not always obliterated by the membranes of the fœtus. The only point not at all involved in doubt in this question, is that the portion of the uterine surface, corresponding with the placenta, can never, in a normal state, communicate with the exterior. As for the rest of its extent, it is possible that the corion does not entirely occupy it, or that it may in part be detached from it without injury to the growth of the embryo.

The retention of the blood of the menses occasions plethora and polysarcia; most of the internal functions are raised to the highest degree of activity, and the mother is in a condition to furnish an abundance of nutritive materials to her uterine burthen.

This latter, endowed with a peculiar modification of life, attracts the more free animal matter to it, in proportion as its own consumption is considerable. Hence arises augmented volume of the vessels of the womb, thickening of its sides, developement of its muscular fibres; and without doubt, also, corresponding increase of the nervous matter entering into its composition; for, the further pregnancy is advanced, the more influential does this organ become; and when the epoch for the evacuation of its contents has arrived,

it exercises a despotic sway over the two nervous systems of the animal economy.

If we follow the fœtus in its developement, we shall find that, towards the expiration of the first lunar month, all is blended together in the form of a small mass, gelatinous, albuminous, oblong, and swelled out towards its middle, having nearly the shape of a short worm, or rather of a vermiform larva; the cord comes out from the protuberant portion, and is thick, short, and funnel-shaped. At this epoch, no organ is distinguishable even by the aid of the microscope; all is white, transparent, and readily dissolved in water.

By continuing to observe this gelatinous mass, we see it developed in the following order. The head begins to be first recognizable, on account of its being larger than the other extremity, and afterwards because we distinguish in it small spots, which mark out the future seat of the nose, mouth, and ears; the heart is seen to beat; small spots announce the future position of the genital organs; the head, at first apparently blended with that of the chest, becomes more and more removed from it in proportion as the neck is defined. At a later term, the tubercles which sprout from the trunk are the first outline of the limbs; these begin with the hand and foot, which have at first a membranous appearance, and which recede from the trunk by the successive formation and growth of the forearms and legs, and of the arms and thighs. This march already followed in the developement of the head, is then common to all the extremities; let us say more, it is that of the growth of the body generally; the most important parts, the principal centres of action, are the first formed; they then recede from each other, in order to give place to the intermediate organs, which, as yet, had been only formed in faint outline.

An important remark is to be here made; it is, that the placenta takes a growth much more rapid than the fœtus in the beginning of gestation. The bibulous vessels composing it set out at first from the umbilicus, from which they diverge; they are afterwards united, and constitute a mass of a funnel shape; but in proportion as pregnancy advances, this mass is removed from the body, and the cord joining them acquires length, giving the same kind of developement as of the head and limbs. As the placenta is the preparatory organ of the nutritive juices of the fœtus, it attains its growth before the latter, and is only exceeded by it in volume at a tolerably advanced period of pregnancy.

We shall not stop to repeat after authors, the account of the growth of the fœtus, corresponding with the different epochs of gestation, because our knowledge is not sufficiently advanced to enable us to deduce therefrom any conclusions applicable to pathology. It is sufficient for us to have directed attention to the general mode of evolution of the new being; it consists, as we have said, in the visceral masses being the first formed; in their being very close to each other, and as it were blended together; in their then separating in proportion as the intermediate organs are developed; in the extremities of the limbs appearing likewise before the other portions; and finally in the placenta offering the same peculiarity in relation to the umbilical cord.

It is very desirable that we should possess details of the growth of each of the organs which form the masses of the viscera; such observations have been made as regards the brain. Tiedemann, setting out from the data furnished by Gall, has remarked that the superior portion of the medulla oblongata is the first seen, and the cerebellum and the hemispheres of the cerebrum appear like small prominences, which gradually enlarge while receding from the primitive tubercle, and finally exceed it in volume. We always find then that the most important organs are the first formed, and that the others are detached from and grouped around them. This does not imply the assertion that they are produced from them, but only that they are at first in close approximation, and then separate while acquiring size, and allowing of the growth of the intermediate tissues.

We are of opinion, that the shock of vital electricity, if we may be allowed the expression, which constitutes conception, must mark out, in the small gelatinous mass, the route which is to be traversed by the nutritive juices, in order to the formation of all the organs; or, if other phraseology be preferred, that this commotion impresses on the molecules an intestinal movement, whose continuation must produce the arrangement under which all the organs will be formed. We believe that the female furnishes, at least in major part, the matter of the embryo,* but that the arrangement which disposes this matter in the form of an embryo, only takes place at the moment in which the two matters are brought in

* The facts proving this are most numerous. The egg of the bird, the roe of fishes, are only provisions of nutritive matter destined to supply the embryo until the time in which it can provide for itself by articles from abroad.

contact. We do not mean to affirm that the impetus belongs exclusively to the male; were it thus, the child would constantly resemble its father, whereas it presents at one time the perfect image of its mother, and at another that of the father, and more frequently the combined features of both parents. I have likewise very frequently observed, that the child, while it exhibited the most characteristic features of the father, had the constitution and temperament of the mother, and *vice versa.* Now these united facts do not allow us to believe, either that the fœtus is secreted and formed complete by the mother, only receiving from the father the impulse determining its growth; or that the father has the exclusive privilege of giving to the prolific matter secreted by the mother, the motion by which its organs are to be arranged. We are then of necessity compelled to admit that the vital impulse, or the movements of affinity of vital chemistry, which mark out the first lineaments of the fœtus, proceed from both parents. The animal substances prepared in each of them for generation, are inert until the moment in which they are united; but so soon as that of the male has simply touched the surface of the ovary, it penetrates it in spite of the thin enveloping serous lamina. Then begin the intestinal movements, the molecular vital attractions which are to make up the fœtus. They doubtless do not thus produce it at the first moment, but by their continuation they finally form it.

The embryo derives its first nourishment from the small mass of fecundated gelatin enclosed in the cell on which the semen of the male has operated. It is at this epoch free, and is even so during all the period in which it traverses the Fallopian tube; but when it has reached the fundus of the uterus, this small mass, though enlarged by the imbibition or attraction, which it made of the adjoining juices, is incompetent to its nourishment. It has been consumed, and the embryo is already furnished with bibulous vessels to form its placenta: so soon as these vessels have vegetated on its surface, they are implanted on the part to which they correspond. Hence, if the descent into the uterus has been retarded by any accident, and if the Fallopian tube, losing its vital erection, abandon the surface of the ovary before having absorbed the small ovum, the embryo which it contains, still continuing to grow, will apply its placenta either to the tube, or to the ovary, or to the peritoneum, and, by means of the irritation to which it will give rise, will extract from this spot the juices of which it has need for its growth. This

is what constitutes extra-uterine pregnancies, of which we shall seek the causes in the pathological section of this chapter.

When the child contained in the uterus has completed the period of its growth, the womb has likewise arrived at the degree of irritability which no longer allows the new being to remain in its cavity. We say to the degree of irritability, and not to the degree of distention, because, in fact, experience shows, that a uterus holding two children, and consequently much dilated, is not sooner relieved of its burden than that containing but one. It is then rather the duration and increase of the irritation of the uterus, than the volume of irritating foreign bodies, which determines the effects of ejectment. As to the first cause of the impatience of the uterus, it is as useless to seek for it as to pursue that of all the other periodical phenomena observed in the exercise of the functions.

The efforts at expulsion seldom begin in a sudden manner. The uterus at first slowly contracts from its fundus to its neck; the female perceives that her abdomen is constricted, and that her burden is directed downwards, and the head of the child strongly engaged in the cavity of the pelvis. The labour is at its commencement announced by pains sympathetically referred to the loins. These pains soon become more defined; women compare them to colics, and they who are inexperienced even go to the water-closet; but, at last, the true character of the pains is exhibited, women declare that they are of a peculiar kind, and, if the physician observes them, he makes the following remarks.

So soon as the uterus begins to contract, the abdominal muscles become harder and participate in its efforts, the diaphragm taking part at first involuntarily, and afterwards by the influence of the will, which is solicited and forced by the nature of the pain. The woman is then compelled to act involuntarily, not only on these muscles, but also on all those which concur to the performance of respiration, and to interrupt this function, in order to aid the efforts of the uterus. Nor is this all; she is also obliged, in order to furnish a point of support to all these muscles, to employ the ones which serve for locomotion, by chosing the posture most favourable, and grasping with her hands the bodies around her, and pressing, half bent, with her feet against whatever is near her.

It is by means of these combined and repeated efforts continued for some hours, that the neck of the uterus is dilated, the sac containing the waters is protruded and ruptured, and that the head of

the child traverses the straits of the pelvis, dilates the opening at the vulva, and is finally expelled. The uterus, continuing to contract on itself, next expels the after-birth, which is composed of the placenta and of the membranes in which the child had been enclosed.

After the delivery is over, there are great changes in the order of vital functions. The uterus begins to disgorge itself, in proportion as it contracts: at first it expels pure blood, soon after sanguinolent lymph, and finally nothing more passes but puriform mucus, the consequence of inflammation which remains in its internal membrane subsequent to the detachment of the after-birth. It is about the third day from the delivery, and when the uterus has ceased to discharge pure blood, that the secretion of milk, for which the mammæ had been prepared during pregnancy, begins to take place in great abundance. As it is impossible, consistently with sound physiology, to say that the blood is directed towards the mammary glands, we are compelled to admit that the vital action, which was spent in the uterus for the nutrition of the child, is replaced by that which presides over the secretion of milk. The change of place in the theatre of the irritation, supposes that the uterus is connected with the mammæ by a peculiar sympathy. This is manifested in all the menstrual epochs by an increase of tumefaction and sensibility in these organs, and seems to be more evident during pregnancy, since, in proportion as the uterus acquires size, the mammæ are enlarged and even sometimes secrete milk. But it is when the uterus is entirely freed from the stimulation which had been irritating it for nine months, that the above sympathy is evidenced in its highest degree of energy; the mammæ are swelled and heated; they send to the heart, and over the entire apparatus of the great sympathetic, irradiations which give rise to a febrile movement; but so soon as the mammary glands have taken on secretion, this exacerbation is diminished and dissipated in a true crisis, by an abundant excretion of milk, always accompanied with a more or less copious sweat.

This first effort being over, the milk and sweat flow during some days, without any fever; and, if the sucking of the child does not keep up the secretion from the mammæ, they dry up, the sweat ceases, and the uterus regains its habit of periodical congestion and hæmorrhage. But if the mother become nurse, the uterus continues in a state of inaction, until the mammæ ceasing to be irritated,

it may once more return to the kind of normal action which it must preserve during the entire period of fecundity.

If next we examine under the heads of instinct and the intellectual faculties the female just brought to bed, we find maternal love developed, immediately on the child which she bore seeing the light. This love, partly physical and partly moral, is prolonged during the entire period of suckling, were it only by the power of instinct, which sways the intellectual faculties, when these latter are not diverted from it by a series of ideas derived from another source, a case very happily of most rare occurrence. As an instinctive impulse, it is weaker as the child grows larger; but it preserves afterwards all its intellectual character, and extends through a period longer than that in which it is operative with the females of other animals. We will not now stop at considerations of this nature, which we have treated of in the chapter on instinct and on the intellectual faculties; but we must here call to mind, that the state in which the visceral nervous system is found after child-birth, is in harmony with the moral condition of the woman; for this fact is susceptible of applications to pathology.

Section III.—*In what manner the Action of the Genital Organs becomes the Cause of Diseases.*

The mere preliminary of the generative acts, desire, may become a cause of disease. As a mental emotion, when it encounters opposition, it causes disease in the encephalon and visceral apparatus: hence acute and chronic insanity, partial deliriums, palpitations, convulsions, suffocations, attacks of asthma, constriction, and heat in the stomach, which may lead to latent and even acute gastritis. In a word, there is none of the diseases which we have referred to the depressing emotions, to those which are founded on the alternations of pain, anger and pleasure, that may not recognize as a cause the mental excitation resulting from the obstacles encountered by man, to the gratification of his venereal desires.

We have said that there were examples of spontaneous rabies produced by this cause: these must be considered as the effects of nervous irritation, which becomes excessive in the fauces, encephalon, and salivary organs, and in the entire apparatus of the great sympathetic.

The desire ungratified sometimes produces priapism or satyriasis in man; and in woman it may give rise to nymphomania; but as

the female sex is destitute of the stimulus of the semen, they are less exposed than the other to the excess of genital irritation, unless certain depraved habits should produce in a direct manner this irritation on the parts submitted to their influences. But in return, reason is in greater danger in woman than in man. We must not overlook the involuntary pollutions, especially the nocturnal ones, which forced continence occasions in certain men in whom the secretion of semen is very abundant, and which are often very difficult of cure.

Coition may be the source of a great number of accidents more or less serious. In the first place the extraordinary afflux of blood to the cerebral substance may give rise in it to an effusion, which occasions sudden attacks of palsy and apoplexy. The excess of enjoyment may even be suddenly fatal without the effusion of any appreciable quantity of blood, and by the simple effect of the accumulation of this fluid in the cerebral substance. It seems to us probable that the blood has then passed the limits of the normal state, and that there exists a more than ordinary extravasation in the encephalic parenchyma.

The violence of the palpitations which always accompany the generative act, shows how much the heart must suffer in those who indulge in it to excess. This cause is even adequate to the production of aneurisms: but they who are already affected with them are much more exposed: hence we often see such persons suffer from violent attacks of orthopnœa, after coition, because the heart too distended refuses to receive blood from the lungs; or else we hear of their perishing in the act itself; and autopsia has sometimes exhibited a rupture of an auricle or even of a ventricle, with a sanguineous flooding in the pericardium. Coition too frequently repeated, debilitates the heart, and the circulation languishes.

The fits of asthma, following the efforts of coition, may likewise depend on a certain degree of hypertrophy of the heart, plethora, and a convulsive disposition of the bronchial tree. It is nearly the same with hæmoptysis; for the suspension of respiration concurs with the augmented violence of the pulsations of the heart, to accumulate blood in the lungs, and to bring about the extravasation and discharge of this fluid.

When indulged in immediately after a meal, coition cannot fail to disorder digestion in delicate persons: the excess of sensibility developed by this act in the epigastric region, is participated in by

the sensitive surface of the stomach: there results an afflux of blood in the vessels of this viscus, violent pulsations, an increase of heat, and even pains sufficiently intense to produce a fear of sexual enjoyment in persons who are afflicted with chronic gastritis; and we know how great is the number of the unfortunate thus afflicted, thanks to the prodigious vogue of the emetico-cathartic, deobstruent, and tonic method! In general, venereal excesses debilitate the stomach, and after an agreeable warmth give rise in it to a sensation of coldness and languor, which seems to invite a man to have recourse to stimuli; but this uneasiness is also indicative of over-irritation, and, if we give into the practice of curing it by stimuli of too energetic a nature, we necessarily bring on a morbid state.

The effect of coition is also strongly felt in the urinary apparatus. The urethra is at first irritated, then the neck of the bladder and the prostate gland are similarly affected, with often an extension of the irritation to the bladder and the kidneys; these parts become very excitable, and disposed to contract inflammation under the influence of cold, or of stimulating drinks, or even by the mere effect of the act itself; the urine imperfectly combined in the kidneys is decomposed in their pelves, or in the bladder, and calculous diseases are the consequence.

Simultaneous excesses in the use of wine, high-seasoned food, and the pleasures of Venus, rarely fail to bring on nephritis, cystitis, and gravel.

The eyes always participate in the irritation of the genital act; they become sparkling and injected, and finally acquire an excess of sensibility, and a disposition to take on engorgement by the slightest irritation. This is one of those causes which most powerfully tend to produce chronic ophthalmias and loss of sight.

Coition is never performed without a considerable excitement of the muscular system, which will even go so far as to produce convulsions. It is not then astonishing that debility should be the immediate effect; and, if the indulgence be too frequently repeated, it becomes the cause of permanent asthenia: hence men, who habitually abandon themselves to this kind of excess, are ill able to bear painful and continued exercises. It is known with what care the athletæ of ancient Greece, abstained from venereal enjoyment. To the same influence must we attribute the diminished strength of voice after such excesses. In order to preserve that of their singers, the Romans had recourse to the infibulation of the prepuce;

but the lubricity of some rich matrons soon contrived, if we are to credit Juvenal, to overcome this feeble obstacle: *Gaudenti cantu nullius fibula durat.*

There is an important tissue, the functions of which are powerfully deteriorated by venereal excesses; I now speak of the skin.

The excitation of the heart, and increased muscular movements, cause much blood to arrive at it; the skin is heated and reddened, and perspires freely; but a calm having succeeded the excitement, the perspiratory process and the impelling power of the heart are diminished; the skin is pale, and remains more susceptible. If cold impress it, there is a deficiency of reaction, and rheumatic and gouty phlegmasiæ, and engorgements of the large viscera, are the usual results.

It is therefore, on one side, by giving rise directly to visceral engorgements, and on the other by raising the excitability to such a degree as to exhaust and favour the action of other causes capable of deranging the equilibrium, that the abuse of venereal pleasures becomes so potent a cause of infirmities: it is also from not having well understood this kind of action, that physicians have so often aggravated the diseases of persons, who have committed excesses of the above nature, in neglecting to attack the visceral congestions by suitable means. In the old practice, it was sufficient that a man was suspected of having yielded with little reserve to the pleasures of love, for the medical adviser to reject, with a degree of horror, the emission of blood, and to have immediate recourse to the employment of the most active stimuli.

Venereal excesses are not alike hurtful to all persons. The abuse is much more easy in man, because he loses more than woman, and undergoes more debilitating efforts; but if the latter carry the repetition to such a degree as to be an excess for her sex, she will unquestionably have to dread more disorders, as her nerves, being more feeble, will more readily contract a convulsive habit, and the visceral congestions, always renewed by the menstrual returns, will present greater obstacles to the cure. It is erroneously that certain persons repeat, by a kind of echo, that women brave with impunity excesses of this nature; experience too surely proves, that they of the female sex, who abandon themselves in this way, soon lose all their freshness of complexion, become dyspeptic, contract pectoral diseases, inflammation of the vagina, with flux and eating chancres, have menorrhagia, occasioned by irritation of the neck of

the uterus, and they often perish the victims of ulceration of this part, and of the disorganization of other viscera.

Among men, the most nervous are the greatest sufferers, because they are susceptible of excesses to which stronger but less irritable subjects could never give into, and because these excesses never fail to produce congestions in the brain, heart, and lungs. We learn from this, how reserved, on the score of venereal enjoyments, ought to be those young persons of an irritable and sanguine temperament, whose chest is narrow, and heart very active, or even hypertrophied. Such a constitution almost always gives them a propensity for sexual enjoyments, and their facility furnishes a triumph which seduces them; for a man considers himself to have so much the more prowess and vivacity as he is strong in coition, an illusion which is the cause of his destruction. I have known many, whom the fear of losing their advantages in this latter respect kept obstinately away from bleedings, low diet, and other debilitating means, the only ones which remained to them, in order to escape the phthisis with which they were threatened.

For the appreciation of the effects of coition on the health, the physiological physician must hold in mind the facility or difficulty of the seminal ejaculation in man, and of the act which corresponds to it in the other sex; for the more difficulty there is in obtaining this result, the more the excitation which is there yielded to for its accomplishment is violent and perturbating. This is what we always observe in those who, from ill-timed self-love, or vicious habits, are hurried away into enjoyments which greatly exceed the wants of their constitution. In this way originate hæmoptyses, aneurisms of the heart, convulsions, paralyses, distortions of the spinal column, and many other diseases, the obstinately untractable march of which we are often witnesses to, without being able to find a satisfactory reason for them.

Of all the ages, childhood and adolescence have most to suffer from venereal excesses, on account of their liability to hæmorrhages, visceral congestions, and convulsions. These latter frequently come on during the act itself, and readily become habitual in such subjects. How many epilepsies are there not dependent on the same cause? The unmeasured repetition of these kinds of excesses rarely fails, at those epochs of life, to bring on stupidity and dementia.

The adult age is that which incurs least danger from venereal en-

joyments; but they are frequently fatal to old men, less by bringing on premature decrepitude, than by giving rise to apoplexy in those who are threatened with it, or in causing relapses in those who have already suffered from its attacks. One of our medical friends, who has for a long time superintended many mineral springs in Spain, has observed that the paralytic who visited them to obtain relief from their maladies, almost always traced their first attacks to the effects of a venereal congress. It is unnecessary to add, that aged people affected with hypertrophy of the heart, and we know they are in great numbers, run the triple risk of the rupture of that organ, suffocation, and fatal apoplexy, if they do not succeed in conquering this imperious habit, which tends to bring them back to the pleasures of another age.

It is a well established fact, that the same men may repeat the act of coition with less fatigue in warm than in cold climates. We cannot explain this difference otherwise than by that of the secretion of the semen: this fluid being more abundant in high temperatures, its excretion requires little effort; but if it be wished to repeat the act as often in cold and cloudy climates, the difficulties that are encountered lead to a super-excitement, of which we have sufficiently appreciated the dangers. At any rate, we must likewise confess, that venereal excesses have also inconveniences in southern, which they do not present in nothern latitudes,—of provoking excessive perspirations,—exciting thirst, and predisposing to gastro-enteritis, by inducing man to make an abuse of stimuli and tonics, with a view of renovating his prostrated powers. This same prostration renders him also more susceptible of being affected by the humid cold of night; and also by marshy exhalations, the influence of which is so dangerous in those climates. It results, finally, that these sorts of abuses are attended with still more inconveniences in southern than in nothern regions.

Conception may become to women a fruitful source of disease. In order to form an idea of this, it is sufficient to recollect, that the absorption of the ovum requires a certain time, during which the fimbriated extremity of the Fallopian tube must remain in apposition with the ovary. This permanence depends upon that of the erection of the tube, which latter in its turn can only be kept up by the vital erection or organic irritation, which has been established in the ovary since the ejaculation of the semen, and which will not cease until the prolific drop shall have been detached from it. But where is the organic irritation, however deep-seated

and slow it may be, that cannot be affected by a powerful moral emotion? Is there a part irritable and supplied with nerves, to which the brain may not transmit the commotions it receives during surprise, anger, fear, &c.? It would, therefore, be possible, that a lively emotion of the soul could cause the detachment from the ovary of the extremity of the tube by which it is embraced, before it has effected the absorption of the fecundated ovum. But as the embryo by which it is filled is a true parasite, to which all parts of the body are indifferent, so soon as the moment shall have arrived, when the gelatinous mass which contains it will no longer suffice for its nourishment—so soon as it shall project from itself the imbibing vessels of its placenta, it will implant them on the portion of fixed animal matter within its reach, and will there definitively fix itself. If, then, the separation of the tube from the ovary takes place before the ovum has reached the uterine cavity, the embryo, having attained that degree of developement we indicated, but of which it is impossible to fix the period, will attach itself, either to the ovary, or to a point of the tube, or else in the peritoneal cavity, and extra-uterine pregnancy will be the consequence.

A case related in his thesis, by Professor Lallemand, furnishes an example of this kind. A very erotic woman had compelled her husband to gratify her desires in the day time, without even taking the precaution of locking the door. At the moment of the ejaculation a door opens with violence;—this woman feels an extraordinary commotion in her abdomen;—her pregnancy is irregular, attended with many accidents; and death, of which it is not my business to describe the precursory circumstances, affords an opportunity of discovering that the child had been formed in the cavity of the pelvis. Its placenta was adherent thereto; an inflammatory exudation, which the author compares to the membrana decidua,* lined the whole of this cavity, and blood-vessels had become developed in the part corresponding with the placenta, at least as much as the texture of the peritoneum would allow.

There are cases in which the placenta has been found attached to the external surface of the uterus,—in others it has been discovered on the intestines,—in others in the Fallopian tube,—in the fimbria-

* The cavity of the uterus was lined by a similar production, from which M. Lallemand concludes, that the uterus was sympathetically irritated by the influence of the fecundated ovary

ted extremity of this latter, or on the ovaria, &c. It is easy to conceive what accidents must result from such attachments, and particularly those that would take place on the intestines, or on the stomach if it descended sufficiently low down.

The fact related by M. Lallemand is of a nature calculated to elicit reflections. The moment of surprise and terror, which this woman experienced, destroyed suddenly the erection of the tube, and detached the fimbriated extremity from the ovary; this appears to me beyond doubt; but did the ovum fall at the instant in the cavity of the pelvis, or only a few days later? The first case would suppose that the prolific drop is absorbed by the tube, and carried to the uterus at the very instant of conception. The second would be explained by saying that the fecundated ovary produced and expelled slowly its little ovum, which, not finding at the instant of its detachment, the tube at the proper place for receiving it, has necessarily fallen into the abdomen, and fixed its placenta to the nearest part.* Other facts will doubtless serve to elucidate the present one. We know, that observers admit that the ovary fecundated by the spermatic fluid, requires a certain number of days to project its ovum; and that it is in order to wait for it, that the fimbriated extremity of the tube, kept in a state of erection by the irritated ovary, remains in apposition with it. But were this really the case, I am surprised that extra-uterine pregnancies should so rarely occur; for during the number of days supposed requisite for the detachment of the ovum, women are often exposed to moral emotions as vivid as that of which I have just spoken, and not less capable of destroying the vital erection of the tube, which maintains its fimbriated extremity in apposition with the ovary. At any rate, the present reflections are only offered in order to elicit new researches on these important subjects. I say important, for if the detachment of the ovum requires so long a period, women can hardly be taken too much care of during the days immediately succeeding conception; but, how can we judge of this latter, when the woman herself is not conscious of it?

The obliteration of the cylindrical canal of the tubes, is, without doubt, the most frequent cause of sterility in women, by preventing the spermatic fluid from reaching the ovaries. This reflection must

* The first abdominal pain was felt on the night succeeding the accident: it persisted during the whole course of pregnancy, and was situated at the place of insertion of the placenta in the pelvis.

make us sensible of the great importance of curing uterine inflammations that might occasion the obliteration of the mouths of these canals.

The emission of semen is rarely a source of disease to man: yet it may happen that the sudden suppression of the spermatic excretion by a powerful moral sensation, will develope an inflammatory movement in the epididymis, or in the body of the testicle. Examples of the sort are on record; but it must not be supposed that there can result from this the imperfect procreation of an embryo, as some authors have believed; inflammations, more or less intense and painful, and, as a consequence of these, sub-inflammations, are the only effects of these accidents.

When the embryo, has arrived in the uterus, and begins to acquire a little strength, it excites strongly this organ, already irritated by the stimulating action of the semen, and the influence of the fecundated ovary, and produces a true inflammatory fluxion on the internal surface of the uterus. It is then that the sympathies of this organ may be observed and pointed out in the most satisfactory manner; and this is surely equivalent to what some affect exclusively to call direct experiments. The first relation noticed in nervous or delicate women takes place with the stomach, for the appetite becomes altered and depraved, or vomiting supervenes. These phenomena, which are generally regarded as nervous, and which inspire no fear, may also be the prelude of very intense acute or chronic gastrites, or gastro-enterites. We cannot too often repeat to those physicians who are always ready to prescribe large doses of ether and other antispasmodics to every person who vomits, that the above-mentioned conversion is so much the more to be dreaded, as the predisposition to gastritis or gastro-enteritis existed in a higher degree before pregnancy.

These gastrites are further an object worthy the utmost attention of physicians, inasmuch as it often happens, that young girls are only deprived of their menses in consequence of a chronic gastritis; they become pale, are pronounced to be chlorotic, and physicians recommend matrimony. This latter is consummated, and soon pregnancy, adding to the irritation of the stomach, developes an inflammation, the progress of which it is very difficult to arrest. We even have examples of vomitings provoked by pregnancy, which have obstinately continued, in despite of all the efforts of the art, and have proved fatal, although the inflammation of the stomach was very trifling. In such cases the modification of the

stomach was more nervous than sanguineous, but of such a nature as to resist antiphlogistics as well as stimuli. It is never prudent, therefore, to advise matrimony to persons whose stomach is morbidly irritable. The exceptions that might be adduced to this rule, are not sufficiently numerous to destroy it.

In its progress, pregnancy gives rise to polysarcia, and to sanguineous plethora. Under these circumstances, women become subject to pulmonary oppression, vertigo, and palpitations. Their flesh is of a firm consistence; their colour high; they walk with difficulty; they are exposed to spitting of blood, and to inflammation of the large viscera, more particularly of the lungs; and threatened with convulsions, uterine hæmorrhages, and abortions, if care has not been taken to prevent these accidents by bleeding.

The weight of the uterus drags down continually the abdominal muscles, and its volume and elevation are opposed to the lowering of the diaphragm, especially in women of small stature: the bladder being compressed, is emptied with difficulty, and sometimes too easily; constipation is continual. The compression made upon the iliac vessels, acting more upon the veins than the arteries, retains the blood in the inferior extremities, and produces, in individuals of a soft and lymphatic constitution, varices and œdema.

In those who have borne many children, the abdominal parietes yield, and the belly falls upon the thighs, from which results a very unpleasant dragging sensation; and the linea alba being greatly dilated, gives rise to ventral, umbilical, and other kinds of hernia.

Such are the principal derangements of which pregnancy is usually the origin, in women of a delicate constitution, who have been brought up in idleness, or who are too nervous; but in compensation, we occasionally notice advantageous modifications in the functions: the irritation of the uterus sometimes serves as the remedy of habitual inflammations. We see the symptoms of gastro-hepatitis, when this inflammation is not very intense, dissipated in some women. In others, chronic pneumonia is suspended in its destructive progress, and health seems to be re-established. But this amelioration is not always of long duration, and seldom continues beyond the period of utero-gestation, which, for curative purposes, is always too short.

As soon as the epoch for the expulsion of the fœtus has arrived, the efforts which this function necessitates, produce, by interrupting the circulation, a stagnation of blood in the principal viscera. From this may result, in women whose plethora has not been di-

minished by sufficient bleedings, irritations of the heart, which may be changed into organic diseases; congestions of the lungs, which predispose this organ to become, sooner or later, the seat of a fatal inflammatory fluxion ; accumulations of blood in the brain, which produce convulsions; draggings of the peritoneum and its subjacent cellular tissue, which predisposes to peritonites; and finally, a rupture of the diaphragm, cervix uteri, or perineum, and in cases in which the pains are strong and frequently repeated, and the cervix resisting, a rupture of the uterus itself. In some instances, and in consequence of some peculiar disposition of the woman, accidents of a totally different nature supervene ; I allude to the slowness of the labour, from the weakness of the uterine contractions, the detachment of the placenta, and the hæmorrhages which are the consequence of this latter accident. But all these circumstances are too well known to accoucheurs, to require to be enlarged upon here. I consequently pass on to the diseases that are the consequence of parturition.

These result from the laceration of the neck of the uterus and perineum, as well as from the loss of blood; either in consequence of the too great violence of the congestions which take place in the uterus at the moment of labour, or from the slowness of the inflammation which necessarily exists in the internal surface of this viscus, particularly in that part of it to which the placenta adhered, and from the inflammation of its appendages, the unfortunate effect of an incomplete disgorgement. These irritations of the uterus give rise to a number of secondary affections both acute and chronic. It is thus that the inflammation of the cervix and fundus is converted into phlegmon, or traverses this organ and produces peritonitis; or else remains chronic, particularly that of the cervix and ovaries, and occasions organic alterations which sooner or later prove fatal, when the females have been so unfortunate as to be subjected to the influence of stimuli, before these centres of inflammation had become extinct.

If we extend our researches to the organs that sympathise with the uterus, we shall see its influence, or else the premature cessation of its irritation, develope in them a variety of inflammations. In this series the most conspicuous are the inflammation of the mammæ, and slow glandular engorgements, which at a later period produce a carcinomatous degeneration; the consecutive developement of gastrites and pneumonias, some of which having only been suspended by pregnancy, become once more acute after parturition; the cere-

bral irritations which give rise to insanity, unfortunately the too frequent result of child-bearing, in those cases in which an excessive use of stimuli has been made, particularly in women whose minds had been tormented by grief.

We have seen that the skin constantly served as an emunctory for the serous and lymphatic fluids, which are always too abundant in females who have lately borne children, but who do not suckle them. In some cases, and commonly in those in which the woman has been too greatly excited, and in which the impression of cold has deranged the course of the depuratory excretions, the skin contracts acute inflammations of the erysipelatous kind, or else participates in the inflammation of the cellular tissue, from which result large œdematous phlegmons, particularly in the lower extremities. Others may, if they please, explain these diseases, by means of the spontaneous metastasis of the milk; but as regards myself, I cannot see any thing more in them than an abnormal direction of the irritation which is so evident after parturition,—an irritation which should be limited to the secretion of the mucosity of the uterus, and to that of the skin, and of milk; but which is called towards other parts through the influence of a large number of perturbating causes, such as cold, affections of the mind, immoderate and premature stimulations of the digestive organs, which nurses and some imprudent physicians imagine necessary to produce, in order to repair the loss of blood and strength. We cannot too much insist upon the necessity of abstinence, and of the antiphlogistic treatment after parturition, because the inflammatory diathesis is obstinate and reappears with facility when it was thought to have been removed. This occurs even when women have begun to suckle: with so much the more reason, then, must we fear it, when owing to some circumstances they are deprived of this precious advantage. Cases occur, however, in which parturient women incur the danger of dying, from debility and inanition. These accidents generally take place after difficult labours, in consequence of a profuse flooding; and nothing is more easy than to recognize them by the sensation of debility, by the smallness of the pulse, paleness, coldness of the extremities, depression of the abdomen, and presentiment of death.

As the skin may contract acute inflammations, so it is not protected from those of a chronic kind; thus we see herpetic affections, scabby pustules, with swelling of the sub-cutaneous ganglions, succeed derangements in the excretion of the mammæ. By the vulgar, these affections are regarded as occasioned by the milk, and they

thus designate them, a long time after the cessation of the secretion of that fluid; but the physiological physician cannot discover any thing more in them, than an irritation of the skin which has succeeded that of the breast, and which, in consequence of not having been destroyed at its onset, has become a vicious organic habit,—a chronic sub-inflammation. From these considerations he will be careful not to expose the digestive organs to perpetual super-excitements, with the view of evacuating a pretended milky humour.

Section IV.—*Of the Diseases of the Fœtus.*

The fœtus may be attacked with the inflammations by which its mother is affected, and with others that are peculiar to it; hence we see some come into the world with gastrites and enterites, accompanied with enlargements of the mesenteric glands. The child may carry with it pulmonary inflammations, and tubercles which are a consequence of them. A commotion, or a sharp contraction of the uterus, may cause rupture of the membranes, which as yet are soft, and under these circumstances the head contracts adhesions to them. According to M. Geoffroy Saint Hilaire, such is the cause of anencephalus, and he explains it in a manner, the details of which must be read in his works. Two embryos placed in contact with each other, whilst they are as yet gelatinous, may unite,—which constitutes another kind of monstrosity: one may grow whilst inclosing the other in some part of its body,—which, at a later period, occasions abscesses, in which are found the rudiments of a fœtus.

The child may also be born with imperfectly formed organs,—with imperforations,—vicious directions in some of its viscera; important organs may be wanting,—others may be too voluminous; there may exist supernumerary ones, &c.

CHAPTER XIV.

OF THE DEVELOPEMENT, CONSISTENCE, AND DECAY OF MAN.—OF THE VARIOUS TEMPERAMENTS.

When the child comes into the world, the only organs that are fully developed in it, are such as are fundamental and the most necessary to life; that is to say, the brain, heart, lungs, digestive viscera, and the passages for the expulsion of the superfluous portion of the mobile animal matter. If we examine it at this epoch, we remark that the circulation is very rapid, but that the serum and lymph are in excess in the vessels, whilst the fibrin is in small proportion; and gelatin predominates in the solids and fluids. At this time absorption is very rapid; there is yet but a small portion of cellular tissue, which is filled with gelatin. The bones and muscles are incomplete; sensibility is only aroused for the first wants, and sleep returns as soon as they are gratified. Yet all the organic sympathies take place with the greatest activity. The head and abdomen are very voluminous in proportion to the rest of the body; the lungs, although large, are far from having the degree of predominance they will one day acquire, and the thymus gland still occupies a part of the space destined for them. Of all the parts of the body the head is much the largest, relatively to the others.

At this epoch, the only wants which appear at all well marked, are those of respiration, nutrition, the discharges of superfluous matters, rest, sleep, and external caloric; all the others are nearly null. That of self-preservation is only aroused by pain, and not being kept up through the influence of the mind, is no longer manifest, so soon as the child has ceased suffering. The little being is purely a creature of instinct, and a stranger to intellect and the passions.

In proportion as the child advances in age, we may notice the developement, at first, of the external parts, the growth of which is very rapid; the head preserves a long time its predominance of volume; but soon the bones of the face, and the jaws, in which the teeth are to show themselves, enlarge, and cease to be disproportioned to the volume of the cranium. The arms grow, though much less than the lower extremities; for nature prepares the child for sustentation and walking. The pelvis enlarges, and, from oblique that it was, tends to become horizontal: the child tries its strength, supports itself, and walks; and gradually, the pelvis being

enlarged and straightened, a part of the intestines is lodged therein, and the volume of the abdomen appears to be diminished. Whilst this occurs, we remark other changes—the external senses are developed, with the exception, however, of that of smell, which, until the period of puberty, is not as keen as the others. The intellect is enlarged from day to day, and begins to modify the instinctive suggestions. The circulation, though not quite as active as before, is still very much so. During lactation the child becomes very fat; but afterwards grows thin, in proportion as the locomotive apparatus acquires developement, and the period of puberty approaches. In this interval, absorption continues to take place with great energy, the bones become incrusted with a calcareous phosphate, the muscles are developed, and fibrin begins to exist in larger proportion in the blood-vessels, whilst the serum and lymph are continually diminishing in the same proportion. Sensibility is extreme, the nervous system acquires a great degree of mobility, transmitting with rapidity the vital erections, which are also very numerous, and re-establishing the equilibrium with an astonishing promptitude. The intellect acquires a very great extension. The attention is with difficulty fixed upon abstract ideas; but memory, being singularly predominant, retraces with great facility words and the other signs of our ideas, although judgment has as yet acquired but little strength.

The desires predominating from the first periods of infancy to the age of puberty are, nutrition, which may be gratified with the utmost facility; that of the discharge of superfluous matter, which is always urgent, but gradually becomes less so; that of muscular exercise, which is not less imperious than the want of nutrition; those of repose and sleep; that of self-preservation, which is tolerably powerful; but, having only a faint consciousness of danger, or relying on its agility in avoiding it, the child appears to be less timid than the adult: he is, simply, less prudent. The love of observation is also very well marked; for the curiosity of children is excessive, and it is in consequence of this that they acquire all their information; it is from the power of example and their extreme facility for information, that they contract habits which will one day lay the foundation of their conduct in society. The passions are less numerous and durable in children than in adults, owing to the imperfection of their intellect; but anger is, in them, so frequent and intense, as to compensate sufficiently for its short duration.

Puberty, prepared by the general growth of the body, and by that of the pelvis and of the extremities that are attached to it, gives rise to a change in the physical and moral nature of the individual. So soon as the sexual organs begin to acquire volume, they become covered, in both sexes, with hair. The semen secreted by the testicles, in the male, fills up the vesiculæ seminales, and produces the erection and growth of the penis. Stimulated by the vital erection of the ovaries, the uterus is developed, and converted into a centre of sanguineous fluxion, which being exalted every month, furnishes the menstrual hemorrhage. The vagina becomes enlarged, the orifice of the vulva is tumefied, contracted, and surrounded with fat, and the mammæ are developed. The changes in the other organs are not less remarkable; for the voice, which previously was always acute, becomes grave, particularly in man. This change depends on the prodigious growth which the pulmonary apparatus, the most sanguineous and arterial of all the viscera, undergoes, together with the heart and large vessels. The chest soon obtains in the male sex a degree of predominance over the abdomen, although this latter does not lose any portion of its vigour; but as it is less arterial and at a greater distance from the heart, it cannot equal the thorax in point of developement, when the youth enjoys the plenitude of strength common to his species. In woman, the pelvis frequently exceeds the chest in breadth.

The limbs are enlarged and lengthened rapidly in the youth of both sexes, whilst, at the same time, the vascular sanguineous apparatus becomes developed:—it is not difficult to conceive the connexion of these two orders of phenomena. The bones, which as yet are incompletely hardened, allow for some time growth in length, which even sometimes becomes more rapid than before puberty: the rapidity of growth is in direct ratio to the degree of irritation in the circulatory apparatus, and to the softness of the bones. We shall point out the consequences of this when on the subject of the pathological changes it occasions.

So soon as the bones are definitively consolidated, the growth is limited to a thickening of the tissues. In subjects of a good constitution, we only notice the enlargement of the fleshy portion of the muscles, which become more or less well defined under the skin. Weak subjects present a growth of the bones, tendinous parts, and cellular substance, by which they are deformed. But here we observe a well marked difference between the two sexes: in vigorous males the fat appears to be dissipated at puberty; whilst

in females the cellular tissue is developed and accumulated, as Roussel has remarked, around the two sympathizing centres—the sexual organs and the mammæ,—whence it appears to spread in the neighbourhood of the pelvis, and on the thighs, legs, shoulders, and arms, in order to bestow on those parts that agreeable roundness to which we attach the idea of beauty. Yet we must remark, that if the muscular prominence does not set off the form of these various parts, there is no longer either grace or beauty.

All the functions acquire, at the period of puberty, an increase of activity, which they are long to preserve. Circulation is active, calorification rapid, nutrition energetic, absorption very considerable, and the vital erections very easily excited, and very strong: these last, owing to the nervous activity, being always very great, are transmitted from one part to another with nearly as great rapidity as in children. Contractility, which is generally very considerable, is particularly so in the muscular apparatus, either locomotive or visceral. Reaction is very powerful; and the secretory organs, and those of the periphery, receive and dissipate with great facility the super-excitements of the principal viscera.

The desires that predominate at puberty are manifestly those of nutrition, of muscular movement, of generation, and particularly of observation; for reason, which has just suddenly manifested itself, causes every object to be viewed in a different light, and curiosity, having now a different direction, cannot fail to become more active and general. Perception is, at this time, very easy, and the power of attention much stronger than in children; memory is not diminished, and judgment, which is nothing else than reason, can draw very advantageously from all the intellectual materials. Still, however, this last faculty is yet very far from attaining the point which it will one day reach: the vivacity of the sensations, and the too powerful agitations they give rise to in the viscera, will yet prevent for a long time, the intellect from operating with perfect independence. The age of puberty is that of the passions, and as soon as one of these becomes predominant, judgment ceases to be free, and reason appears as if suspended. The love of self-preservation is so much the more urgent, as man feels now that he enjoys a greater degree of physical and moral power to resist the causes of destruction. It is the period of courage, of temerity, and of every kind of heroism.

In the period of life denominated that of consistence, which succeeds the entire developement of our organs, and extends, in man

from the thirty-fifth to the fiftieth year, but often terminates a little sooner in the other sex, he does not remain stationary; for though losing insensibly the prerogatives of youth, he yet retains them a long time, and finds in what is acquired an ample compensation for the daily losses he constantly meets with. The circulation becomes a little slower, but in exchange it is more equal and regular; calorification is not diminished in a very sensible manner; the plumpness which man acquires, by preserving his heat, compensates him for a minor evolution of caloric, which, however, now becomes appreciable. The muscles still continue for a length of time to increase in size, and if they lose on the score of rapidity of movement, they on the other hand retain a considerable contractile power. Fibrin continues to predominate; the serum and lymph are in less quantity; and absorption, though still easily effected, is not so energetic. The secretions are also diminished, but the adipose exhalation becomes more considerable. The vital erections, though still intense, are not so easily transmitted; by which the activity of the sympathies is very considerably diminished, particularly in the organic functions; a kind of change this, which favours the maintenance of equilibrium and of health. The nerves of relation have as yet lost no part of their activity; and in many instances sensibility even becomes more considerable. The intellectual operations are very prompt, but memory begins to fail in those in whom it was not naturally very powerful. The visceral sensations, though still very strong, derange with much less facility the equilibrium of the functions.

The wants are greatly modified during the course of the period which occupies us. That of nutrition is diminished, but the stomach may receive from stimuli a degree of energy, by which this diminution is concealed. As the waste is less considerable, because the want of muscular exercise has become less urgent, this increase of assimilation turns to the profit of the sanguineous plethora, and of the adipose cellular tissue. The want of external caloric is felt towards the end of the period we are examining. The discharge of excrementitial matters becomes more difficult, and this is one of those wants which begins to be fatiguing. The desire of repose and of sleep, increases at the same time in which that of exercise diminishes. The love of self-preservation gradually increases in proportion to the diminution of the strength, combined with the increased knowledge of danger; yet it is still powerfully repressed

by the exercise of thought. The desire of generation is preserved, but grows less urgent in the male sex; in the female, on the contrary, it disappears as she approaches the end of the present period. The love of observation is still very great; intellect acts very powerfully, and daily overcomes, more and more, the passions, which diminish with the activity of the circulation, and the facility of the transmission of vital erections. This diminution, however, is only very evident, in reference to the passions that originate in the physical wants; for those of a moral nature continue to enjoy a well-marked predominance, and always in ratio with the previous exercise of thought. Yet it must be confessed, that the predominance of the intellect, and the continued exercise of judgment, which may become, at this period, the regulator of actions, are powerful moderators, from which man derives considerable assistance. It is towards the termination of this period, that the female loses her menses, in consequence of the diminished activity of the uterus; and she then ceases to be prolific.

When he has attained the fiftieth year of his age, man declines with greater rapidity than during the preceding period; but we notice here very considerable differences, which are subordinate to the strength of each individual. Some are deteriorated in an almost insensible manner, and assume, with difficulty, the appearance of old age; whilst others, on the contrary, seem to decay visibly. However this may be, the following are the changes that occur with the progress of time. Muscular contractility becomes slower; man is now heavy, and supports with difficulty the efforts of an accelerated progression, though he may still enjoy great strength. The lower extremities, which are developed last, suffer first from debility. The pulsations of the heart decrease in frequency; fibrin begins to be diminished in the capillaries, and is concentrated in the large vessels, whence results fulness of the principal viscera; the adipose tissue increases in quantity, in individuals of a sanguineous and in those of a lymphatic constitution, and renders the movements more difficult. Sweat is more easily excited; the mucous secretions more and more abundant; but that of the semen is diminished, and, together with it, the energy of the genital erections: assimilation becomes daily less rapid; but, in the normal state, it never ceases to be proportioned to the want of nutrition; it is the most tenacious function of the economy. Sensibility becomes blunted in the external senses, though more particularly in those of

sight and hearing: it is still very keen in the other parts of the nervous apparatus of relation, and the mind operates with the greatest precision.

Whilst man goes through this longer or shorter period of decline, his wants are modified in a very remarkable manner; the want of nutrition diminishes; that of respiration becomes more urgent in old people who have acquired flesh; those of the discharge of excrementitial matters are keenly felt and with difficulty gratified. The want of external heat increases; that of self-preservation is very greatly developed; whilst that of muscular movement diminishing from day to day, the desire of repose finally becomes predominant, although sleep be more difficult and of shorter duration. The desire of generation persists in man until old age; but loses insensibly its energy. It has been noticed, that men who have lived very long have preserved the generating power to extreme old age. Hence it would follow, that the disappearance of this admirable faculty is a foreboding sign of approaching decrepitude. The same remark is not applicable to woman; for the cessation of this want announces always in her the commencement of the decline; the contrary is only noticed in certain pathological states. The love of observation is one of those that experience the most sensible diminution towards the end of the period we are now examining; but judgment does not eease to be improved until caducity.

It is during this period that the primitive shades of the hair are lost, and that these latter become white; but this change presents great varieties. There are individuals, particularly among men, who begin to be gray headed before their twenty-fifth year, and whose hair is all white before they have reached the thirtieth year of their age. The same does not occur, however, in respect to the beard, for it rarely changes before the twenty-fifth year, which is truly the period at which the first white hairs are noticed, in most individuals, either on the head or on the face. Some persons attain to the age of forty-five or even fifty years, before becoming gray; but at sixty years, we hardly find one in several hundreds whose pilous system does not contain numerous white hairs.

The withering of the flesh, the wrinkles and folds of the skin, and the general weakness of contractility, do not follow the same course as the discoloration of the hair. A number of individuals are yet fresh and vigorous, although their hair is entirely white; whilst others appear faded and worn away, but preserve the primitive colour of their hair and beard. A circumstance constantly

accompanying the whiteness of the hair, is a certain and peculiar yellow colour, which, however, harmonizes well in some subjects with the redness and fulness of their flesh. We have not as yet been able to discover if those families whose hair whitens prematurely, offer many examples of great longevity; but we have noticed several premature decays among individuals whose hair acquires that colour with difficulty. We often see very robust individuals, whose hair becomes gray or even white, a long time before their strength begins to fail: whilst, on the contrary, we often notice an obstinate persistence in the primitive colour of their hair, in individuals of a delicate constitution. Men, though stronger than women become gray-headed much sooner. The hair whitens often before the beard and the eyebrows, and the beard, in some, is already quite gray, before the hair is changed. The hair of the surface of the body almost always whitens after that on the head, but we often find the contrary to be the case; I have seen the hair of the genital organs almost entirely white in a young man eighteen years of age, whose hair was black, and whose beard was hardly visible. In a word, there is nothing more irregular than the discoloration of the hair. Hence, it would be in vain to endeavour to deduce from it the progress of decay; fear, and uneasiness of mind, may render the hair quite white without a proportionate diminution in the vigour of the body. The same obscurity attends the falling off of the hair. We are not sufficiently acquainted with the physiology of the pilous capsules, to be able to draw satisfactory inductions from the change of colour, and loss of the hair.

The duration of old age is exceedingly variable, and cannot be deduced with certainty from the degree of vigour manifested by each individual in the prime of life. We see in very many cases athletic men arrive prematurely at decay, and appear as if curved under the weight of their own body; whilst thin and small subjects are exempted from the infirmities of old age, and die before they have arrived at the period of decrepitude. Hippocrates had already made this observation. The period of decrepitude is by no means fixed; it is more frequently manifested about the eightieth year, but there are some privileged individuals who only show evidences of it at a much later period, and who are yet vigorous after having completed their century. As long as the aged man is not decrepid, it is impossible to fix the period of his death; so soon as he becomes so, we can easily foresee that he has but a few years to live. As a general rule, men of robust constitutions, who are

neither too sanguine nor too fat, but whose muscles are vigorous, are those who attain the greatest age. Persons of a lax habit, whose muscles possess little power, speedily reach the period of decrepitude; which is recognised by some unequivocal signs.

All the voluntary movements are slow and painful; the full habit of body disappears and gives place to marasmus; the skin becomes discoloured, flabby, and wrinkled; the voice seems cracked, tremulous and feeble; the utterance is indistinct; the eyes are dim, sunken, and with difficulty distinguish objects; the hearing is depraved or entirely lost; taste and smell still remain; the knees are half bent, and the limbs incapable of complete extension; the vertebral column yields to the weight of the viscera, and is bent forwards, which compels the old man to seek for support in the use of a staff, in order to preserve himself from the falling with which he is constantly threatened; the laws of gravitation have overcome the resistance of contractility, and the physical henceforth prevail over the vital ones; the triumph of general over organic chemistry is equally progressive, and evidenced by the imperfect assimilation of the fluids; scarcely have the excretions been evacuated from the organs, when they begin to be decomposed, and a universal fœtor, exhaling from all the surfaces of the body, evidences the slight coherence of the elements that enter into their formation. The blood is poor, as it is commonly expressed; by which is meant that it contains but little fibrin, or crassamentum, that the serum is considerable, and that the gelatin, as also the albumen, possess little consistence, and are easily decomposed. The number of capillary vessels are very much diminished, as injections demonstrate; and a great number of the gelatinous tissues having ceased to be penetrated by this vivifying fluid, become cold, obstructed with lymph, and sometimes ossified; as is also seen in the tendons, aponeuroses, and arteries. All the apophyses of the bones become more projecting, although the size and weight of the latter themselves may be diminished; for the bones of aged persons have less bulk and are lighter than those of adults. The teeth do not exist; the alveolar processes, by sinking, leave them exposed and the obliteration of their nutritious vessels hasten on their decay and fall. The heart contracts slowly and irregularly, and its want of impulsion is one of the causes which have produced the disappearance of the small vessels. Absorption is feeble, for the contractility being weakened cannot overcome the physical laws in the interior of the vessels, as it does in muscular masses; the fluids are as obedient to

gravitation as to the vital powers: hence those œdematous swellings which are seen about the ankles, and which frequently deform the legs of old decrepid persons. Digestion is nevertheless still performed, and is even capable of acquiring, by means of stimulants, a power which carries nutrition beyond the wants of the individual. Sensibility is wonderfully diminished, and the transmission of weak vital erections which may still take place is so difficult, that the majority of the sympathies have disappeared, and the reaction of the interior towards the exterior is feeble, and in dangerous diseases absolutely impossible.

The wants of the decrepid old man are very much diminished; but those which he still has are very urgent. If the aged person who is yet vigorous, can endure abstinence, the one who is decrepid on the contrary cannot bear it. He requires, indeed, little food, but it is all-important for his preservation that he should always obtain it, and that it be of a good quality: the wants of excrementitial discharge, very difficult to satisfy, become an inexhaustible source of evils to the aged; the desire for exercise has almost entirely disappeared, and that for repose has become permanent; but sleep, although very necessary, is at this age extremely difficult. The desire of generation no longer exists; that of observation is very much diminished: the sensitive impressions are so obscure and feeble, that the aged individual neglects them, in order to seek in his own memory for ideas better traced out and more capable of satisfying the want of thought. The reason of this phenomenon is very plain: it is because the organs of the senses are much more enfeebled than the centre of perception, which, located in a viscus of the first order, must persist with it until the last moment. We are not, however, to believe that the memory may be renewed after it has grown old with the rest, since it is no longer exercised but in an imperfect manner upon the actual impressions, and we know that too often it perverts the remembrance of things. The subjects of whom we are now speaking, approach the infantile state in this particular, that they become almost entirely the creatures of instinct: in fact, attentive only to the wants relating to their preservation, they are regardless of all impressions which have not a bearing upon this subject. We observe them listless and inattentive in the midst of a numerous circle, or at least allowing to pass by unheeded the greater part of the ideas which have not a direct relation to the only want with which they perceive themselves harassed, that of retaining the life which appears almost to

escape them; so true it is, that nature only concedes to intellect the portion of action of which instinct has no need. The decrepid old man also resembles the infant in the readiness with which he becomes irritated at all the obstacles that are opposed to the gratification of his wants. Finally, nervous power and muscular contractility having been exhausted, the action of the heart ceases, and life terminates with the stoppage of the circulation, before the capillary tissues of the mucous lining of the digestive and respiratory apparatus have lost the power of assimilating and absorbing the materials necessary to the prolongation of existence.

Such is natural death, called the death of old age; but there are so many causes capable of destroying the equilibrium before this fatal period, that this termination is of extremely rare occurrence. We shall wait for the data which will be furnished us by the different temperaments, before we indulge in an inquiry into these causes.

Section I.—*Of the Temperaments.*

By the word temperament, we mean the differences that are observed between men, and which are dependent upon the relative predominance of each of their organic systems. Galen, who first directed attention to these differences, established them upon heat, and cold, dryness, and moisture, and associated these four qualities with the predominance of four humours, which he considered as playing the principal parts in the human body, viz.: blood, bile, phlegm, and the atrabiliarious or black bile, a kind of humour, the source of which he located in the *capsulæ renales*, and which on this account bore the name of atrabiliary capsules. He accordingly recognised, 1. a warm and moist temperament, which he attributed to the blood, and which he called *sanguineous;* 2. a warm and dry temperament, which he named *bilious;* 3. a cold and moist temperament, which bore the title of *pituitous;* 4. a cold and dry temperament, which received that of *melancholic.* But as the temperament may be at the same time sanguineous and bilious, sanguineous and phlegmatic, bilious and melancholic, &c. we perceive that it would be absurd to admit that a man could be at the same time, moist and dry, hot and cold, fat, and lean: we also discover, by the progress of vitalism, that the humours are not the causes, but rather the effects of the modus operandi of the solids; that the black bile is not produced by the capsulæ renales, since it is nothing else but altered

bile or blood. Hence we seek for a better foundation of the difference between the temperaments.

The celebrated Professor Hallé referred them to the relative predominance of the different organic systems of Bichat: he distinguishes them into general temperaments, which are associated with the developement of the general organic systems; and into partial temperaments, which are dependent on the developement of certain apparatus. He bases the sanguine temperament upon the predominance of the vascular, arterial, and nervous systems; he lays down an athletic temperament which arises from the predominance of the muscular system, and refers the lymphatic temperament to the developement of the system of that name, and to that of the adipose tissue; finally, he proposes to give the name of nervous to those temperaments characterized by remarkable activity of the sensitive system, and points out, as examples, not only the melancholic of the ancients, which has become synonymous with a moody, thoughtful character, but also all the fat or lean constitutions, whether delicate or robust, which are endowed with a lively sensibility, whatever may be the moral character of the individuals.

It is the opinion of this professor, that the bilious temperament depends on the extraordinary activity of the digestive apparatus, and he thinks that we may discover others of a similar kind: thus the relative predominance of the encephalon, of the lungs, of the heart, of the sexual organs, particularly in the female, constitute, according to him, so many partial temperaments, which, however, can be associated with the general temperaments, just as these are combined with each other in different proportions.

M. Bégin, in his Treatise on Pathological Physiology, has designated these partial predominances by the term *idiosyncrasies;* but this expression does not appear to us at all suitable, because common use has for a long period appropriated to it a meaning totally different. In fact, the term idiosyncrasy has always been employed to convey an idea of certain remarkable phenomena which we observe in our relations with external agents, and which are far from corresponding with the predominant developement of any particular organ. The idiosyncrasies depend constantly on the manner, altogether inexplicable, in which our organs of relation are affected by their modifiers: for example, certain objects which affect some persons in an agreeable manner, produce disgust and aversion in others; certain articles of food are rejected by the stomach; others cause an extraordinary irritation, producing convulsions,

eruptions, or irritations, in the bladder and in the genital organs, of which other individuals afford no example. There are some persons who cannot digest certain aliments, unless they are taken at fixed hours, or prepared in a peculiar manner: we see some who never drink when they are in health; and others are met with who can digest only in a certain posture. I am acquainted with a lady in whom the odour of a linseed poultice produces a violent suffocation, and, if she cannot escape from it, she is attacked with a stinging erysipelas of the face. A Prussian captain, whom I saw at Paris, in 1815, could not bear the sight of a cat, a thimble, or an old woman, without becoming convulsed and making shocking grimaces: a great number of persons have a dread of a particular animal, as of a mouse, a spider, or a toad: some females faint at the sight, or from the perfume of a rose, whilst this beautiful flower forms the delight of the generality of persons, &c. Such are the phenomena that are designated by the term *idiosyncrasy*, and we cannot associate them with the predominant developement of any particular organic apparatus. Now, as it is necessary that these words should possess a meaning generally adopted; and as it is not possible either to prevent the term idiosyncrasy from recalling to our minds these phenomena, or to replace it by any other which shall convey the same idea, I do not think that we can employ it to express the predominant developement of the visceral apparatus.

The varieties of temperament should, in our opinion, be associated with those of functions. We proceed therefore to attempt the classification of them on this foundation, in availing ourselves of the profound views which the illustrious professor Hallè was in the practice of developing in his lectures upon hygeine.

Predominance of the first assimilation, owing to the extreme developement and energy of the digestive apparatus, makes the *gastric temperament.* It is often combined with hypertrophy of the liver, the secretion of which is in excess: this constitutes the *bilious temperament.* Persons of this temperament are described as with black hair, a thin and muscular body, much strength and vigour, and lively passions. But nothing is less fixed than these pretended characteristics. We can only say that their great power of assimilation supposes always a high degree of vigour.

Predominance of hæmatosis makes the *sanguine temperament.* It is often associated with the preceding, but not necessarily so; for we often meet with great eaters who bear badly and repair with difficulty losses of blood, whilst a number of persons remarkable

for their sobriety, always have the vessels filled, and repair the loss of blood with aliments ever so little substantial. The sanguineous have not always the highly coloured complexion, a circumstance which depends on the organization of the teguments of the face, and which is common to other temperaments. They are also far from having always the chest full, the heart large, the pulse much developed, and the veins dilated. We meet with very many who have a small heart, a pulse of moderate force, and veins of inconsiderable volume. We must, however, still concede that hypertrophy of the lungs, heart, and vascular sanguineous system, is very often associated with this temperament. It is the same case with the muscles, which are usually very large in sanguineous persons, in whom the fibrin is for the most part very abundant. The athletic form is commonly combined with the simultaneous predominance of the first assimilation and of hæmatosis; that is to say, with hypertrophy of the digestive apparatus, lungs, and sanguineous vascular system. This coincidence establishes, when not excessive, the highest degree of vital energy of which man is susceptible; these kinds of temperaments never fail to lead to obesity, so soon as they have attained the limits of growth in thickness. We must take special care not to confound them at this time with lymphatic subjects. It would be erroneous, in imitation of most authors, to attribute to the sanguine temperament, gaiety, levity, inconstancy, vivacity of mind, and fondness for that kind of life called epicurean. Such dispositions are the effect of an organization of the sensitive system, modified by the social state, and may be conjoined with any other temperament; we may, however, affirm, that the facility of assimilation and hæmatosis, gives activity to the brain and food to the passions, advantages which man too frequently abuses.

The sanguineous predominance may very well be combined with that of the lymphatic juices, forming the *lymphatico-sanguineous* temperament. Persons of this constitution have a fulness of habit from their very youth, and are throughout their life loaded with blood and lymph; their body is soft, and awkward in its movements, though possessing strength and heat. Their viscera are always engorged, their mucous membranes secrete freely, and their lymphatic ganglions are more defined than in the temperaments already described. This constitution, may, like the preceding ones, present all the shades of colour of the skin and hair from the white to the deep red, from the fair to the black. The mental qualities are subordinate to the developement of the brain. This is

the most usual temperament of children, and, among adults, of women, who recede less than men from the physical and moral characters of early life.

Feebleness of assimilation and of hæmatosis, gives us the *anemic temperament.* This may be found in a thin and haggard body, and, if at the same time the sensibility be not exalted, this temperament will not be found to correspond with any of those mentioned by writers. It is the feeblest constitution of all, and prevails to a great extent in large cities, where our species degenerates. The flesh is soft, the muscles thin and without strength, the skin is pale and ash coloured; all prolonged exertions, whether of body or mind, are insupportable. These kind of persons are only possessed of some energy during their youth: they do not bear evacuations of blood; they wither prematurely, and their children cannot be raised without extreme difficulty. Whenever the anemic temperament is accompanied by a certain fulness of habit, it corresponds to the simple lymphatic of authors: but in its greatest degree of emaciation it does not merit this term, for the lymphatic apparatus is in fact very irritable among subjects of this description, as we shall find when treating of their pathology. This temperament is compatible with every kind of colour: to the lymphatic are usually assigned as characteristics flaxen or chesnut coloured hair, and blue eyes; but we find weakness and anemia in their highest degree, among the idle, and the inhabitants of large cities of warm countries, though they have black hair and dark skin. It would be incorrect to attribute intellectual weakness, stupidity, and apathy, to the lymphatic temperament. If their sensitive apparatus be well developed, they possess as great energy of the intellectual faculties as the most robust constitutions, and may be endowed with very strong passions. But strength is wanting to enable them to turn these precious faculties to a useful account; intellectual labour wearies them, and the passions destroy the equilibrium of their functions to such a degree, that the anemic are afraid of, and dare not yield to them.

Predominance of sensibility, the excess of which easily gives rise to convulsions in the muscles of every description, constitutes the *nervous temperament.* It is either innate or acquired; a distinction this to be well attended to. It is innate in very thin persons, and may then be associated with the predominance of assimilation and hæmatosis,—forming the *bilioso* or *nervoso-sanguine temperament;* but it is more usually allied with the anemic temperament,

for the greater number of thin anemic persons are nervous. It is almost always developed in the course of life, by prolonged irritations of the internal senses and encephalon, even in the athletic and the fat and lymphatic. This is a point of which it becomes us to be apprized. The passions are not necessarily exalted, as has been pretended, in nervous persons. We only find them to be so with a certain encephalic developement. It is equally false that their imagination is always lively; we meet with many in whom this faculty is at its minimum; but what essentially characterizes them, is their exaggeration both of pleasures and pains, and their proneness to convulsions and visceral spasms.

The predominance of the nervous system does not impress a peculiar character on the animal economy, since it is combined with every grade of assimilation and hæmatosis; we cannot then assign to it either peculiar forms or colour. If the encephalon be very large, the nervous phenomena are more multifarious, and neurodosia becomes predominant in the mental faculties. If the heart be voluminous, or the lungs small, nervous phenomena will predominate in the chest. It will be the same case with the gastric passages, the kidneys, and the uterus: but it is not the nervous state that gives rise to these partial predominances; they are innate or acquired, and may be met with in all constitutions.

It seems to us desirable to give an idea of that state of the animal economy, to which ancient authors affixed the title of *melancholic temperament*. It is, say they, characterized by a thin yet robust body, large veins, a face pale and elongated, flesh firm, deep and enduring sensibility, black and smooth hair, slow and difficult digestion, with frequent eructations, acid and bilious flatus, a yellowish tint of the skin, and a decided propensity to sadness, with peculiarities in the character, which make such subjects be looked upon as eccentric, or a kind of crazy persons. To them, however, is conceded much imagination, and even genius. This assemblage of traits is not necessarily met with in the same person. We find in them the physical peculiarities of persons with a gastric predominance and a nervous state, which may depend on many causes; sadness is the effect of the sufferings of the viscera, or else it depends, together with an exaltation of ideas, on the peculiar organization of the brain, and in such cases it may be coincident with fatness as well as leanness. It is now a long time since the melancholic temperament of the ancients has been considered as a pathological state. We have only recurred to this question in order the

better to analyze the different elements of which it is composed, and to trace the mental part of this pretended temperament to its true source, the organization of the brain. As regards the picture of the melancholic, what we can advance with some confidence is, that it represents in general a person with a gastric predominance, attacked with a chronic inflammation of the digestive organs: and, as this is often met with in men of studious habits, it was thought necessary to rank the melancholic among persons of talent. It was doubtless they themselves who drew their own portrait.

Section II.—*Application of the Temperaments to Age and Sex —Diseases thence resulting.*

In early life, the lymphatic temperament predominates: but it is stimulated by a slight degree of the sanguineous in vigorous subjects; nervous irritability is always extreme, and the digestive apparatus is very active. The diseases resulting from this state of things, are inflammations of the digestive canal: they are always accompanied by cerebral engorgement and convulsions; and often depend on dentition; for the irritation thence resulting reacts on the head and abdomen: cutaneous and erysipelatous phlegmasiæ, and hardening of the cellular tissue, are common disorders at this period of life.

The second infantile period, which begins after the eruption of the first twenty teeth, and extends to puberty, presents a temperament less lymphatic, somewhat more sanguine, but still very nervous, and always accompanied with great gastric irritability. The irritations of the encephalon are very frequent but less violent in them; enterites are especially predominant, and assume the name of atrophy in the first half of this period on to second dentition. Worms are often connected with these complaints at this time. Eruptive cutaneous phlegmasiæ bear in them paramount sway. Finally, hypertrophies of the head, leading to hydrocephalus, ganglionic sub-inflammations, and softening of the bones, are the attributes of this age, and are especially observable in those whose temperament is more lymphatic than sanguine; nor shall we be surprised at this, when we reflect that this period is that in which the efforts of growth are especially directed towards the osseous system, and in which there is the greatest formation of gelatin and albumen. We discover how little physiological it would be to regard as ab-irritative modifications, chronic ophthalmias, and other slow

inflammations of the openings of the mucous membranes, as well as the ganglionites in their vicinity; no doubt but general debility predisposes to these maladies, but they are not the less truly inflammatory in their nature, since they exhibit all the characteristics of this condition, and are always made manifest under the operation of stimulants. It is on account of this irritability of the tissues surcharged with lymph, that we find contusions give rise to scrofulous sub-inflammations in the different regions of the body; but as we have explained ourselves elsewhere on the true character of these diseases, it is useless to insist further on the subject.

Puberty is the epoch in which the sanguineous system predominates over all others; it is also that of the most acute inflammatory disorders: these more especially prevail in the cavity of the chest, to which a decided effort of growth is directed, and in the digestive apparatus, which takes on excess of action, in order to furnish the materials necessary for the rapidity of developement. Is it at this age, that the essential, (idiopathic,) fevers of authors are of most frequent occurrence; they are nothing more than acute gastro-enterites, with more or less inflammatory irritation of the encephalon; and if not completely dissipated, the natural predisposition of such subjects to inflammation, keeps them in a chronic state; it is, in fact, during the period of youth, that the greater number of men contract habits of inflammation, which makes their whole life a tissue of disorders. It is to be remarked, as we have elsewhere done, that whenever the growth is very rapid, the visceral apparatus is in a state of continual irritation; the stomach is hot and has great sensibility, though it digests very readily, constituting a kind of bulimia, which may be converted into an obstinate inflammation: the pulsations of the heart are vigorous and frequent, and we often meet with a hypertrophy of this viscus; there is also heat of the lungs, and irritability of the bronchial mucous membrane. If the nutritive juices be strongly invited towards the locomotive apparatus, the pectoral cavity is not sufficiently developed for the free play of the lungs; they remain then too narrow relatively to the volume and force of the heart, and the excessive impetus of blood gives rise in them to hæmorrhagies and inflammations: this is, perhaps, the most frequent preparatory cause of pulmonary consumptions. The efforts of growth are likewise converted into inflammatory movements in the head, articulations, and muscles. The sanguine lymphatic temperaments are those which present the most frequent examples of this kind of epigenesis; on this account the ab-

sorbent ganglions readily contract irritation of the phlogosed tissues, and, if they escape this affection, the other white tissues are attacked and readily disorganized.

The sudden evolution of the sexual organs is attended by super-irritations, manifested in them by continual erections and involuntary pollutions; a kind of morbid state which is extremely rebellious, very fatiguing, and which is often complicated with hypertrophy of the heart and pulmonic irritations.

As low and uniform growth protects adolescents from all these infirmities, and this kind of developement is usually that of robust constitutions, in whom the chest is also broad and deep. Hence, individuals of this formation present the most regular outlines: we, however, meet with some among whom the limbs are not proportioned to the volume of the trunk; but this kind of make does not expose them to any danger, whereas the excessive length of the extremities, even with very well defined muscles, is commonly associated with a narrow chest, which becomes an inexhaustible source of disorders.

The coming on of the menstrual flux is for young women of this conformation an epoch of almost inevitable disease. In fact, the visceral super-irritation, above spoken of, retains the blood and prevents it from being directed towards the uterus; hence, the languor which assumes the name of chlorosis; but the discoloration is only the effect of phlegmasiæ of the chest or abdomen, and woe to the physician who shall be so little of a physiologist as to be ignorant of the fact. The proneness of the uterus to hæmorrhagic congestions, may protect the viscera from the bad effects of emmenagogues; but if this crisis fail, the visceral stimulation makes progress, and draws after it the most fatal consequences.

Man having attained the age of consistence, enjoys the constitution which is peculiar to him. Women frequently retain the characters of the lymphatic temperament, but it is very often modified by the sanguineous; they are more nervous than men, always less athletic, and rarely enjoy so decided a gastric predominance. This is the place to point out the diseases peculiar to each of the temperaments which we have admitted. This task will be facilitated by the considerations into which we have already entered.

The predominance of the first assimilation exposes man to the hyper-irritations and phlegmasiæ of the digestive apparatus; but it is solely because he carries stimuli to excess; for, without this condition, he would discover in this happy temperament a powerful

resource against the physical and moral causes of infirmities. But the facility with which subjects of this kind perform digestion, insensibly leads them to excesses, of which they finally acquire the habit. All are not, however, equally culpable: the greater number commit these faults without being aware of their tendency, because they only give the name of excesses to that quantity of aliment which fatigues their stomach, and to the portion of fermented drink which affects their reason. They do not know that very substantial food, and high-seasoned meals, which they digest without inconvenience, and even with a feeling of comfort, must, necessarily, in the end, over-irritate their stomach: they do not know that a certain measure of wine, which will only cause in them a slight feeling of gaiety, must destroy at last their digestive powers, without its having deranged their intellectual faculties. They only think of strengthening themselves, and conceive they are threatened with a dangerous debility if they neglect to carry their meals to the most complete satiety. If they experience any slight inconvenience, they merely refer it to the excess of blood or bile, and imagine that a bleeding or a purge will suffice to restore the balance of their powers, and enable them to resume their accustomed kind of life: such practices may not be attended with inconvenience in persons who take exercise in the open air, but those of sedentary habits must sooner or later sink under them when they reach the decline of life. Their error, however, is excusable, for in spite of the eulogiums which, since the time of Pythagoras, have been lavished on sobriety, we are still in need of a treatise on physiological hygeine. It is not sufficient to say in a general way, that sobriety is the foundation of health, nor even to prove it by numerous examples; we must show it from a physiological view of the functions of the stomach, and by a faithful exposition of all the shades of gastric irritation, which is developed under the influence of the various ingesta, and followed by the complete deterioration of the health. Such a work ought to become a classical one, and be placed in the hands of all young people. As we exhibited, when treating of the diseases of the stomach, the progress of irritations of this viscus, we need now but refer the reader to the pathogeny of the digestive function.

The temperament distinguished by the predominance of hæmatosis, exposes those who are endowed with it to every kind of phlegmasia and hæmorrhage, which is not long in being converted into a habit. In fact the sanguineous have not only to dread the gastro-

intestinal irritations to which they are so much the more subject as they partake more of the gastric temperament, but likewise to apprehend anginas, congestions in the lungs and head, especially if they have large lungs and a voluminous and very active heart, which forces the blood with impetuosity into important viscera,—a kind of conformation this very common with such subjects. Whenever the sanguineous are exposed to any physical or moral commotions, and that their customary evacuations of blood are suppressed, they must beware of these formidable affections.

Violent exercise, and unusual and long continued efforts, are hurtful to persons in whom the sanguine temperament is decidedly defined; good-living throws them into obesity, and disposes them to all kinds of congestions; their passions are not less dangerous to them; in a word, it is never but with extreme caution, that such subjects succeed in preserving their health, and prolonging their career to extreme old age.

The lymphatico-sanguineous temperament is subject to inflammations of the absorbent ganglions, especially during the period of infancy, and it is always with great difficulty freed from them. Herpes are likewise very common in this state, and are readily produced by acute inflammations of the skin become chronic. It is in women of this temperament that we find the most numerous examples of scirrhus and cancer of the mammæ, and in whom metritis of the neck of the uterus most frequently degenerates into ulcerations. In general, all inflammations have a tendency to become complicated with tuberculous productions in such persons; hence are they very liable to phthisis pulmonalis and scirrhi of the digestive canal. Temperaments purely lymphatic partake of this predisposition; being less irritable, they sometimes tolerate for a long period, the action of stimuli, without seeming to suffer much therefrom; but if the abuse of these agents be carried too far, latent disorganizations are brought about in this description of subjects, the certainty of which is always acquired too late. It happens not unfrequently, that the impression of cold determines in them glandular swellings of external parts, which may last for a length of time, without the viscera being thereby affected, and which even seem to protect them from any attack. But if these irritations, as well as the herpetic and scaly affections of the skin, happen to be repelled, the viscera contract inflammations which speedily run into disorganization, on account of the extreme facility with which the internal lymphatic system participates in the disease. The same

remark is applicable to the suppurations, and all humoral depurations of the skin: lymphatic temperaments having once contracted the habit of these evacuations, cannot afterwards dispense with them without their health being endangered. We explain this peculiarity by the general weakness of reaction which characterizes this temperament; the normal emunctories with difficulty suffice for supporting the balance in their functions, and they readily become tributaries to the unusual evacuations accidentally excited. A moderate but regular corporeal exercise, woollen clothing, and atmospherical heat, are the most efficacious preventives against these evils; but too frequently, the indolence so common in this temperament, leads to a neglect of exercise, and inspires with a fondness for an idle life, the sinister effect of which is attempted to be neutralized by the internal use of stimuli, such as tea, coffee, spirituous liquors, strong wines, and high-seasoned food. Such is, in fact, the kind of life led by the inhabitants of cities in cold and moist climates, where this temperament predominates: they are so much the more inclined to it, as they experience comfortable feelings, and derive a factitious strength, which makes them for a little while forget their natural weakness: but with such practices they rarely fail to destroy their health, and shorten their days. The diseases to which the lymphatics are liable, are then developed, and rendered inveterate, under the influence of the above regimen, and, whenever art is brought in to afford them some relief, disorganization is already too far advanced to take a retrograde course.

Anemic temperaments, though of a dry habit, are not less exposed than the lymphatic ones. Their glands may not be at first affected by the impression of stimuli, but the other white tissues are not the less promptly disorganized; for, though not so much charged with lymph, they are always very feeble, and the weakness of reaction causes a retention in the viscera of the irritations which had not been destroyed at the period of invasion.

We teach in our course of pathology, that all the phlegmasiæ of the exterior of the body tend to advance more and more towards the viscera, either whenever they are renewed, or simply prolonged. This axiom, of which old persons continually furnish the proof, is equally applicable to anemic constitutions; they always become the premature victims to herpes, rheumatisms, or gout, whenever they have had the misfortune to allow these diseases to become inveterate. One of the principal obstacles which we meet with in the treatment of irritative congestions in the anemic, is

that these temperaments do not bear sanguineous evacuations. Revulsion is, then, their principal remedy; but, if we delay its use, it often becomes of no avail. As lymphatic subjects are slow in assimilating, we cannot too strongly recommend sobriety to them; if they deviate from it, lymphatic plethora is inevitable; hence it is only by dint of exercise that they can be on a par, under an exciting regimen.

The nervous temperament is much less unfavourable than the anemic, unless it be complicated with this latter, a result sometimes produced by the prolonged use of stimuli. Such a combination is always most sinister, and forever excludes the hope of perfect health. The purely lymphatic temperament never attains that degree of excitability characteristic of the nervous. A very energetic hæmatosis is not, however, incompatible with neurodosia; but the force of reaction sometimes neutralizes its effects. What we often meet with is the nervous temperament associated with a great activity of the digestive apparatus in very thin persons. This constitution is exposed to a number of disorders; we can readily appreciate the reason of this, by reflecting a little on the manner in which stimulations of every kind affect those persons in whom neurodosia predominates. They live much more than others; they are restless, agitated, tormented by the necessity of feeling; their sensations, always exaggerated, give rise to violent commotions in their viscera, which are repeated in the locomotive apparatus. If we follow their effects in the different organs, we shall find all the disorders to which these temperaments are liable; for the brain, moral affections, by which they are tormented, cephalalgias, megrims, vertigoes; for the heart and lungs, palpitations, suffocations, dry coughs, called nervous; for the digestive apparatus, a great number of painful sensations, contractions, cramps, gastralgias, pyroses, vomitings readily becoming habitual; for the intestines, colics which are not always dangerous in proportion to their intensity, and extraordinary movements; hence they are very liable to hypochondriasis; and we may even assert, that they rarely escape that wearisome disease, if the greatest care be not taken to preserve their stomachs; for the slightest gastritis provokes their general irritability, and carries it to a degree of which persons of another temperament can have no idea. Women of this constitution often become hysterical by the habit of simultaneous irritation established between the uterus and gastric passages. Is it possible for the brain to resist the united influences of these important viscera? We see

it in fact, under the effect of the stimulations which they transmit, give rise to a host of convulsive phenomena in the muscles of relation, which are placed in unison with the visceral apparatus of the abdomen. In our opinion, hypochondriasis differs from hysteria only in the viscera whence emanate the sympathetic influences exercised upon the encephalon; and very often both forms of disease are united in woman. But, independent of the symptoms called hysterical, we find in the female sex, after suppression of the menses, a series of the most astonishing phenomena, consisting in the aberration of the sensitive and motific powers,—phenomena, the appearance of which always announces a temperament eminently nervous. Shall I speak of the surprising derangements of the senses so often observed in nervous persons of both sexes—aberrations of sight, hearing, touch, taste, and smell, which would lead us to infer the existence of very profound disorganizations of the encephalon and other viscera, had we no regard to the concomitant signs which evidence the integrity of these parts?

Acute phlegmasia in nervous persons often present a peculiar physiognomy, which tends to make them misunderstood, and increases greatly their danger; they are always more or less ataxic, and require in their treatment a particular management, which experience alone can teach us. In general, nervous persons are apprehensive of all powerful stimuli, and are never debilitated with impunity by excessive sanguineous depletion and severe abstinence. This is a temperament that requires to be closely examined, which can only be done in populous cities and among the most cultivated classes of society.

We may readily see, from all that has been said above on general temperaments, that the diseases to which they are predisposed break out in preference on the systems and apparatus in which vital action predominates, and that it is important to attend to the particular idiosyncrasies in each person.

Middle age, even when bordering on old age, has not yet destroyed the temperament peculiar to each individual, but it is attended by certain local determinations, which it is important to bear in mind.

The action of the surface is diminished, the exercise is no longer as great, and yet assimilation still continues very active; it becomes more so by the high living, which to the rich is often a factitious, indeed, but nevertheless an imperious want. The formation of blood exceeds, then, the wants of the economy, and plethora is

constantly kept up in the principal viscera: from this arises the numerous evils which commonly afflict idle persons who have reached the age of fifty. The inflammations taking place in the external organs henceforth tend to a chronic character; hence inveterate herpes, the cure of which is not without danger; hence continual rheumatisms and gouts, which only momentarily assume the acute form, and which always threaten to seize on the principal viscera. It is at this same epoch that in men chronic irritations of the genito-urinary organs become very frequent, and that the vaginites and metrites with which women are affected assume a disorganizing character. The cessation of the menstrual flux is not limited to giving rise to epigeneses ; it is a fruitful source of very fatal congestions and degenerations of the viscera. It is at this time that the heart, so long irritated, becomes in some persons dilated and aneurismatic, a kind of disorder this which singularly aids in bringing about a cessation of chronic articular phlegmasiæ. The hæmorrhoidal flux is liable to be suppressed; the cause of which is not in debility, for the persons affected may be full of vigour, but in the irritations of the viscera, which have been prepared and fomented by errors in regimen, compression, and atmospherical influences. Few persons in the well-informed classes, and among the intemperate and idle, arrive at the above-mentioned age without being affected by a gastritis or chronic enteritis, especially predominant in the duodenal region, and productive of sanguineous congestions in the substance of the liver. Now these irritations never fail to be increased at the expense of the external ones, which abandon their first seat. We find asthma appearing not only in persons whose heart is affected, but also in those who have suffered for a length of time under bronchial irritations, or sympathetically from the influence of an irritated stomach. The encephalon is not less in danger than the other viscera, especially in persons of a sanguine temperament, who have recently been freed from habitual hæmorrhages, and in those in whom gastrites for a series of years have been kept up. Mental emotions, excesses at table, coition, the impressions from cold, falls, violent efforts, are commonly the exciting causes of apoplexy; but the predisposition had previously existed. The excessive fulness of the body acquired at this time by certain sanguine habits, cannot fail to hasten the explosion of this fatal malady, which often strikes a man in the midst of apparently the fullest health. I say in appearance, for fulness of body and freshness of complexion are often compatible with chronic irrita-

tions of the viscera, over which such persons think they have triumphed, when they have merely acquired the habit of supporting them. This is explained by the diminution of the activity of the sympathies, which are blunted insensibly with the advance of years, long before the epoch of senile exhaustion has arrived. Hence we rarely meet with very acute phlegmasiæ in persons approaching to advanced life; they only suffer under such from some extraordinary stimulations; but on these occasions they have to dread a fatal termination, whenever the acute state has been preceded by a very chronic irritation.

Old age, though more feeble than that period which borders on and immediately precedes it, is subject to fewer ills: first, because the sympathies have become still less active; then because there is an abandonment of the greater number of habits, the danger of which has been recognised; finally, for the very simple reason, that persons who attain this age are rarely they who had disorganizing inflammations of the viscera. This latter description of subjects usually sink under such diseases between fifty and sixty-five years of age. Very old men are always found among those who, with certain exceptions, (for there are some who attain old age, under great disorders,) have known how to husband their powers, or whom an extraordinary vigour of body has protected from disease. If such subjects learn how to make use of their life, if they have contracted salutary habits, they may prolong their career to the epoch of its normal extinction; but if they commit excesses, they sink in the same manner as those of the age immediately behind them, and with so much the more facility, as reaction is no longer sufficiently energetic to resolve visceral congestions, and as the force of assimilation is too much exhausted to repair losses always brought on by long suffering.

In fact, apoplexies, palsies, aneurisms, pneumonias, and gastrites, often terminate the existence of old persons in a few days, even when their freshness of complexion and their fulness of habit and gaiety seemed still to promise them a certain number of years.

The state of caducity does not belong to health; we meet with few examples of it in persons who have attained an extreme old age. They generally become defunct in a sudden manner, or by a disorder of a few days duration. Caducity is most frequently observable in old men attacked with disorganizations by which nutrition is rendered imperfect, and it is only by dint of great care that art succeeds in prolonging their frail existence. An error of appa-

rently the slightest kind is irreparable: but to undertake to enumerate all the infirmities of this age, would be in anticipation of pathology. What we most frequently observe is, that the senile marasmus, which comes on in spite of the best directed attentions, is an infallible presage of approaching death. But we are inclined to regard it as more frequently the primary or secondary deterioration of the digestive organs, than that of an exhaustion produced by age; for, in the order of nature, the digestive function ought to persist to the last moment, and death, in our opinion, to happen from the exhaustion of the contractility of the heart, by which it ceases to beat.

Section III.—*Of the Alterations in Temperaments by the Influence of the Circumfusa, Habits, and Regimen.*

Man at birth brings with him the temperament of his parents; but it may be altered by the influence of the circumfusa or states of the atmosphere in which he is obliged to live. We now propose examining in succession into the effects of heat and cold, dryness and humidity, light and darkness, regimen and habits, on the constitution of our fellow men.

Atmospherical heat is a stimulant; it tends to exalt the phenomena of life; hence man in general takes a more rapid growth in southern than in northern climates: but we must estimate the degree of the heat, its continuation and intermission. If it be great in summer only, while the spring and autumn are of a medium temperature, and the winter short, man grows freely in all the external parts of his body; he is muscular and robust; the sanguine temperament is most common, and the complexion is dark. If the heat be continual, as in the countries situated between the tropics, man is still more rapidly developed, his skin is of a deeper tint, and complexion bronze or copper-coloured; but his limbs are less muscular and robust. The cellular tissue is extremely condensed, the muscles are less prominent, the temperament slightly sanguine, the digestive apparatus very irritable, and the nervous activity considerable; the genital organs are prematurely developed, and exert great influence over the rest of the animal economy, particularly among women. In cold, but still fertile latitudes, in which the winters are long and very rigorous, whilst the summers are very short, the height is great, the cellular tissue expanded, the sanguineous apparatus developed. Man, more excited through

the gastric surfaces than from the exterior, has more blood and fat, but not always muscles as strong as in warm countries; hence his external forms are less regular. The hair is chesnut or fair, and the skin very white. In temperate climates, in which the winters are short and in duration nearly equal to the warm season, and in which the atmospherical vicissitudes are frequent, the temperaments are various. We find here united the characteristics of the South with those of the North; the vital energy is, in such cases considerable, as in France and a part of Germany. In the regions entirely northern, near the poles, in which the soil is sterile, excessive cold is opposed to the growth of the extremities, which are thin and short; but the trunk is tolerably full, the head voluminous, and the hair brown or red.

Such are the peculiarities which the different degrees of temperature tend to impress on the temperaments; but these are modified by the nature of the soil, exposure to certain winds, buildings, the emanations with which the atmosphere is loaded, and by the kind of nourishment. Thus, on the sides of mountains exposed to the south and east, and well ventilated, man is always of a dry habit of body, very muscular, perfectly well grown, and extremely robust: whereas, in northern exposures not well open to the sky, and in cloudy and humid valleys, we find him weak, rickety, scrofulous, and goitrous: there the lymphatic temperament is predominant. Dry, stony, elevated, and sterile situations, exhibit the inhabitants less robust than those of the mountains, but they are thin, agile, and tolerably healthy. In low, fertile, and shaded plains on the borders of great rivers, the temperaments, on the contrary, are lymphatic and fat; the men have their muscular apparatus but little developed, are weak, often sick, and rarely attain old age. It is not, therefore, abundant nourishment which gives to man his vigour. In fact, the mountaineer, who lives, as it were, only on milk and cheese, enjoys a robust constitution, whilst the inhabitant of the most fertile marshes is languishing and etiolated.

Large cities furnish us likewise with the confirmation of this truth. The nourishment is there abundant and succulent; but the want of light and the effect of humidity render the inhabitants pale, lymphatic, etiolated, and often anemic.

The kind of life led, concurs with the causes which have been enumerated above, to modify the temperaments; its influence is balanced by the latter, which in their turn again are modified by it. In mountainous countries, man is subjected, by the nature of

the soil, to continual efforts, which, conjoined with the purity of the air, must tend to the development of the locomotive apparatus; whilst the strongly solvent property of the atmosphere tends to dry the body and prevent lymphatic plethora. The same agencies operate on him, though in a less degree, in arid and stony plains, and are productive of nearly the same result. These modifications, when combined advantageously, compensate for the weakness of his nourishment, and man becomes very fibrinous and endowed with an expanded chest, though he eat very little meat; even were the heat itself extreme and continued, it would not debilitate him; witness the Arabs of the Desert, and the pastoral and hunting tribes, who exhibit the temperament of mountaineers.

In moist plains and deep valleys, exercise, even to some extent, and the most abundant nourishment, cannot neutralize the debilitating influence of a clouded sky and marshy effluvia; man there falls into an enfeebled state: while, again, the air saturated with water cannot be the bearer of the emanations from his body; whence it follows, that the cellular tissue is charged with fat, and the viscera filled with blood and lymph. Add to these agencies frequent morbid visceral congestions, either of the continued or intermittent type, and we shall find sufficient cause for the lymphatic or lymphatico-sanguine temperament, which prevails in the countries above described.

If we inquire into the influence of exercise in the large cities, we do not find it productive of more advantageous results. The most fatiguing labour, and the most substantial nourishment, cannot prevent the inhabitants from becoming blanched, lymphatic, thin, and even anemic. This is the appearance presented by a crowd of artisans and labourers of every kind, who are not deprived of good food, but work in manufactories, and shops situated on the ground floor or in cellars, and even subterraneous places. As to those who to labours of this nature add the sufferings from want, it is evident that their constitutions will be deteriorated much more, and that not many generations will be required before they arrive at the lowest degree of weakness and anemia. But if to these causes we add the effects of the passions, which are here much more exalted than in the country; and excesses in eating and drinking, which occur from time to time, (at least once a week), contrasting with the usual sobriety; finally, the sedentary life and the trades which force so many persons to maintain a painful attitude, exercising only their arms or their legs, and sometimes even having the chest

or the abdomen exposed to a continual pressure: if, I say, we hold in mind all these noxious agencies, we can conceive how the nervous temperament will be associated with the two preceding ones, and how the local phenomena are produced which tend to organic alterations. Such are, in fact, all weak persons with thin limbs, soft flesh, and narrow chest, who daily sink in the flower of their age, under either chronic pneumonias or gastro-enterites. These phlegmasiæ, on the point of yielding, are renewed by the slightest imprudence, by the least cooling of the atmosphere; they become habitual; tuberculous productions, lymphatic degenerations of every kind, are not long in forming; death strikes the younger subjects before they are married: if they have entered into that state, their children cannot be raised; these latter do not pass the epoch of dentition, or else they are carried off by scrofulas and the eruptive phlegmasiæ; and families thus become extinct after a few generations.

But if, in return, you transport to the country, and to a favourable situation, shattered constitutions, they may acquire strength, and have healthy children, who will become parents of others still better constituted; hence we can conceive of restoration to a vigour of temperament, as well as degradation of the most robust. But man experiences as great a repugnance to leave the city, and become an inhabitant of the country, as he finds temptations in sacrificing the country life to the pleasures of a large city. Whence it comes to pass, that if these latter were not incessantly supplied by robust families, furnished from the country, their population would very perceptibly diminish, and would, by time, be converted into gloomy deserts. It is true, that, in this case, the inconveniences attached to a crowded population, would terminate, by its disappearance, the cities having lost their distinctive characters, to resume that of the country and of hamlets. Such, in conjunction with the crossing of temperaments from marriage, are the modifications under the influence of which man passes successively from strength to weakness, and from weakness to strength; so that, after all, the fundamental type of our species can never be destroyed.

FINIS.

APPENDIX.

A. (Page 41.)

The author has been severely criticised for representing contractility as the only general or fundamental vital property of the tissues; and it cannot be concealed that in upholding this opinion he has laid himself open to censure. We believe that neither M. Broussais, nor any of the warmest partisans of the physiological school, have as yet proved, or will ever be able to prove, the correctness of the views held by them on this point. After carefully weighing the arguments which the illustrious professor of the Val de Grace has brought forward to establish it, as well in this work as in his more recent publication "Sur l'Irritation et la Folie," we have not been able to discover the force which, doubtless, he fancies they possess. An attentive perusal of these and of other works of M. Broussais, in which he treats of the vital properties, convinces us that he is far from having succeeded in making out his case in an indisputable manner.

In the text before us he remarks, that if the true meaning of the words sensibility and contractility are to be understood thus: "The fibre has contracted because it has been impelled to contract by a cause, it naturally follows that the first of these propositions is a necessary consequence of the latter." And he adds, "For if sensibility of the fibre be rendered evident only by its contraction, in saying that the fibre is sensible, we imply that it has contracted."

Before proceeding further on this subject, we must be allowed to remark, that if M. Broussais had not been so explicit in his language and contended for the absolute necessity of contraction as the manifestation of the exercise of the general property of the tissues, we might, perhaps, have supposed, that like many other physiologists he admitted the existence of only one property, and that he adopted for designating it a term different from that employed by his predecessors and most of his contemporaries; applying the word contractility to signify simply what others had understood by the terms excitability or irritability. But it is impossible so to understand him, and we are compelled to recognize that in his opinion, the exercise of the general vital property of the tissues necessarily implies contraction in the part affected.

Now it is precisely this to which we object. So long as M. Broussais's argument applies solely to muscular fibres or parts endowed with the power of contraction, we are ready to allow that he is correct;—we even are willing to admit, that sensibility is invariably the mere effect of the exercise of a vital property. But we believe that the manner of reasoning to which we have referred, will not be found of general application; for the simple circumstance that some tissues of the body possessing in a high degree the power of being excited—of having their vital property brought into play, and of performing, in consequence, certain acts and functions with which they are charged, whenever placed under the influence of exciting causes, do not, so far as we are able to ascertain, manifest, when so excited, those phenomena which are characteristic of the property of contractility properly so called—that is contraction.

It follows, therefore, that when we say these parts are sensible, no one is justified in supposing that they have contracted, for their sensibility is not rendered evident solely by their contraction, but by peculiar phenomena characteristic of the exercise of their vital property, which vary according to the mode of their organization as well as to the particular functions for the performance of which they have been placed in the body. Who, for example, has ever seen a nerve contract, or can furnish the least plausible argument in favour of the probability of such an occurrence? Irritate a cord of sensation, and if the brain be in its normal state, pain will be experienced:—irritate a muscular nerve and motion of the muscle or muscles to which that nerve is distributed will be the result. In each case the vital property of the nerve has been called into play—a sensation has been produced. In the first, the transmission has been upwards and pain has been felt by the brain. In the second, it has taken place downwards—the muscles have been excited, their vital property has been brought into play, and has manifested itself in a peculiar way in the muscle—i. e. by contraction. But we have no evidence, because the muscle has contracted, that the nerve, though it be the agent of the transmission of the excitement, has experienced the same change. If we were to adopt this view of the subject, we should be forced to conclude also that the sensitive nerve which, in the first case, transmitted a sensation, as well as the brain which experienced that sensation, and whose vital property is thereby excited, had contracted.

M. Broussais himself, seems to have felt that this objection would be offered to his doctrine relative to the vital properties; and has, consequently, endeavoured to ward it off. Thus he admits that the internal portion of the nerves is, of all the tissues of the economy, that in which the fibrous form and contractility are demonstrated with the greatest difficulty;—and immediately after this he adds, "that we are reduced to the necessity of admitting both, purely by means of induction." But this, we are inclined to think, is a very illogical mode of reasoning. Indeed the chain of argument, contained in the text, amounts to no more than this—all parts that are fibrous and composed of fibrin contract whenever they are placed in relation with an irritating agent; —some parts composed of gelatin as their principal element, have a faint power of contraction when placed in similar circumstances—ergo, fibres must be admitted to exist in other parts in which there is neither fibrin nor gelatin, and the same parts must be admitted to possess the property of contractility, although no one has ever seen them contract. In other words, they experience a shortening of their fibres; a circumstance which is not calculated to excite much astonishment; since they cannot be admitted to possess these otherwise than through the operation of induction. If M. Broussais could prove that some nerves contracted during the exercise of their function, every one would be forced to admit that they are endowed with contractility. Could he do this indeed, we should be justified in admitting by induction that other nerves which have never been seen to contract, possess, nevertheless, the power and actually do contract during the exercise of their functions, though so faintly as not to be perceived by the aid of any means in our power; for it is not likely that the various portions of the same tissue have different modes of accomplishing their functions. But until this be done, we must be allowed to believe that the molecular movements which take place in the nerve every time nervous action is conveyed through them, are not necessarily attended with contraction; for molecular movement does not always imply shortening of fibres in parts possessing them; and still less can it be supposed to do so in tissues in which these fibres can only be admitted to exist, by the process of induction.

To what we have said in relation to the modification which the brain experiences during pain, may now be added, that, if the author's doctrine on the subject of the vital properties were correct, it would follow that this organ, when it is the seat of that pecu-

liar modification which gives rise to the exercise of the intellectual acts, is in a state of contraction—in other words, a mental operation would be the result of a contraction of the fibres of the brain. Such indeed appears to be the opinion entertained by the author, who talks of the contractility of the brain as of a point settled beyond the possibility of doubt. We need not, of course, dwell long on this subject; for M. Broussais does not appear to have made, and is not likely to make many converts to his views here, or elsewhere, relatively to the physiological question before us, owing to the difficulty of demonstrating the existence of contraction in the brain during the simple exercise of thought, which implies necessarily the exercise of the vital property of that organ, or even the fact of its possessing contractility at all, or the power of shortening its fibres, when operated upon by moral or physical causes. The instance which the author adduces in support of the idea that albumen possesses in some instances the power of contracting, cannot we think, avail him much. We allude to the circumstance that when raised mechanically by the impulse of the blood sent with violence by the heart through all the encephalic vessels, as well as by the effect of expiration, the cerebral mass regains immediately its pristine condition, by means of a movement of condensation directed from all parts towards its centre and basis. Now we suspect that if examined attentively, this effect will be found to be satisfactorily explained by recurring to the elasticity with which the albumen of the brain is endowed, and which enables that organ to regain its natural size after it has ceased to be distended through the instrumentality of any mechanical cause. The same property is possessed by some dead animal and vegetable substances; and surely no one would think of attributing it in them to a power of contractility—a power which implies something active, which in its turn implies the existence of life.

The series of phenomona occuring in the movements of the erectile tissue, as well as in certain actions of the capillaries, is adverse to this creed of the paramount existence of contractility.

But although we are prepared, for the reasons here presented, to refuse admitting the correctness of M. Broussais's views respecting the universality of the property of contractility, and although we maintain, that the exercise of the vital property, whatever it may be, is not necessarily attended in all tissues, with contraction, at least so far as we are able to ascertain, it must not be inferred that we coincide in sentiment with those physiologists who contend for the existence of a plurality of properties. So far from entertaining such views, we believe, that there is in truth, but one general property in the tissues, which we would designate by the term irritability or excitability; and that sensibility, which some have elevated to an equal rank with the other, must be regarded as simply the effect of the exercise of a function.

On the subject of the latter—sensibility, our author appears to us to have gone far to demonstrate its true nature, though we cannot help expressing our regret, as was already done in a foot note to page 125, at his confounding so often, consciousness with sensibility, properly so called.

B. (Page 50.)

M. Broussais has rendered a signal service to physiology and to pathology, by pointing out the impropriety of making use of a vague language, in which physiological phenomena and morbid states of the economy were personified—and the normal operations attributed to the direct agency of certain entities, and the occurrence of disease to the malign influence of others of a different kind. This particular method, traces of which we find not only in the greater number of the medical writings of the

preceding centuries, but in some that have appeared even at a very recent period, and which has served, we have no doubt, to retard the progress of the medical science, has been stigmatized by M. Broussais, by the name of *Ontology*. We can scarcely turn to a page of his works on pathology—his *Examen* and *Commentaires*, or of the *Annales de la Médecine Physiologique*, a journal of which he is the avowed editor, which does not contain some severe criticism of those physicians who formerly used, or continue to use this improper figurative language.

We highly commend the zeal which our author has thus displayed in favour of a reform in the scientific language of our profession; and we are fully convinced that the sooner the practice of converting the phenomena noticed in the animal economy, whether the latter be in a healthy or diseased condition, into something independent of, and isolated, at least in thought, from the organs, is abandoned—the sooner we acknowledge the impropriety of regarding disease in any other light than as the effects of deranged organs, the sooner we shall arrive at the establishment of a rational doctrine of pathology, and be led to a correct system of therapeutics. We are aware of the extreme difficulty of avoiding what M. Broussais denominates ontological language; and have not the smallest doubt that physiologists and pathologists of the preceding and present centuries have often fallen into its use, who, nevertheless, have been and are unwilling to be understood as personifying the cause of the phenomena, or the morbid effects of which they were treating. That such is the case we may infer from the writings of some of the warmest partisans of the present physiological school of France, who often speak with even disrespect of those in whom they discover the slightest tendency towards *ontology*, and who are yet too often guilty, themselves, of employing the figurative language they so unreservedly censure in others. M. Broussais himself, has not always added the force of example to the admirable precepts which he has furnished the medical world; and his warmest friends are forced to acknowledge that he has in many of his publications spoken like a true ontologist.

Without troubling our readers with quotations from his other writings, we must remark that in the present work M. Broussais has *ontologized* in a most unequivocal manner. For example, he speaks of a vital force which presides over the formation, development and preservation of the individual; which resides in contractility, but which is not contractility. This vital force, he says, accomplishes the assimilation of the nutritive substances—extracts from them gelatin, albumen and fibrin, imparts to these forms of animal matter a contractile property—is alone capable of creating animal matter;—creates contractility,—manifests itself by the vital chemistry which is its first, its invisible and immaterial instrument;—an instrument by which it is enabled, through its action on matter, to produce others of a secondary kind, and which are purely material and sensible to our senses. It results from all this, then, that in the opinion of M. Broussais, the vital force exists anteriorly to matter, that it is immaterial, that it employs the vital chemistry, which is also immaterial, for the purpose of operating on the animal matter it has itself created, and thereby of producing material instruments. Than this nothing, surely, can be more completely ontological; for the vital force is here represented as something distinct from and independent of the material parts of the body, in a word, as an entity. Indeed, after reading M. Broussais's chapter on the vital forces, we can hardly be surprised at the pointed remark of one of his commentators, that it is really fortunate, that in all these operations the force in question has thought it worth its while to create animal matter; since without this precaution the actions and reactions of all these immaterial things might have continued a long time without giving rise to any positive result.

This tendency towards ontology, which M. Broussais has so glaringly manifested in the present work, coupled with his severe censure of the slightest figurative language in others, has been one of the causes of the opposition and sarcasm, which the physio-

logical school of medicine has had to contend against. Even some of M. Broussais's disciples have protested against this mode of describing the laws of life,—against the ontological language adopted by that distinguished reformer. "Until this period," says one of them, "the most enthusiastic admirers of Van Helmont and of Stahl, were contented with the admission of one Archeus, or of some other vital principle of the same kind, with the view of explaining the play of the material animal machine, (and this was certainly enough.) But M. Broussais goes much beyond his predecessors. He contends for the existence of two principles. Now, if the vital chemistry,—the invisible instrument of the immaterial vital force was somewhat material, it might facilitate the union of the two substances. But no, the vital chemistry is an instrument not only invisible, but also immaterial, which is used by the immaterial vital force to create material organs."

An equal degree of censure is applicable to the manner in which M. Broussais sometimes reasons in pathology. He speaks of irritation passing from one part to another of the body—of inflammation being translated from the stomach to the toes, or muscles, &c. Take for example the following propositions: "The nerves are the sole agents in the transmission of irritations; this constitutes the morbid sympathies, which are effected in the same way as the healthy sympathies. Those differ from the latter only in this, that in them the nerves transmit a greater degree of irritation, or a mode of excitement which is repugnant to the vital laws." "The irritations of all the organs are transmitted to the brain, where they acquire a certain degree of intensity, especially if they be inflammatory irritations."

We are perfectly aware, that in these and numerous other instances of inaccuracy of language, which might be pointed out in the writings of M. Broussais, this celebrated writer has not intended to convey the idea, that it is precisely the irritation or inflammation of one organ that passes along the nerves to another part of the body. We know him to be too sound a pathologist to harbour such an absurdidea, and feel convinced that his only reason for using the language we have pointed out, has been to convey a fact in the fewest words possible. But this does not exonerate him from the charge of sometimes writing ontologically; and the very circumstance that he has been obliged, in order to avoid circumlocution to do so, should point out to him the propriety of being lenient towards his adversaries, and of not accusing them harshly of labouring under imbecility of mind,—of converting abstractions into real malignant or benevolent entities which produce disease or preside over the operations of the body—in a word of being decided ontologists in the full acceptation of the term, merely because they make use occasionally of a figurative or ontological language.

C. (Page 59.)

A brief sketch of the divisions of the animal kingdom, and of some of the prominent peculiarities of the different classes, in a physiological point of view, will not be misplaced here.

That illustrious naturalist Cuvier, has divided animals into four great groups, viz. 1. The Vertebral. 2. The Molluscous. 3. The Articulated. 4. The Radiated. The three last are avertebral animals, or wanting in a connected series of bones to constitute a spinal column.

The *Vertebral Animals* are divided into four classes, viz. 1. Mammalia or mammiferous animals. 2. Birds. 3. Reptiles. 4. Fishes.

The Mammalia or mammifera, are subdivided into nine orders:—

1. *Bimanus*—Man. 2. *Quadrumanus*—Monkey. 3. *Carnivora*, including numer

ous families. 1. The *Cheiroptera*, or winghanded, as bats. 2. *Insectivora*, hedge-hog—moles. 3. *Carnivora* or *Fera* proper. 4. *Amphibia*, Seal. Morse.

4. *Rodentia*—rats, squirrels, rabbits, the beaver, and porcupine.

5. *Edentata*—sloth—armadillo.

6. *Ruminantia*—ox, camel, lama, stag, antelope.

7. *Pachydermata*—horse, wild boar, hog, tapir, elephant, great mastodon, or mammoth.

8. *Cetacea*—whale, porpoise, dolphin.

9. *Marsupial*—kangaro, opossum.

Birds are divided into six orders :—

1. *Accipitres*, or birds of prey—eagle, hawk, &c.

2. *Passeres*, or sparrows—singing birds, humming bird, bird of paradise.

3. *Scanseres*, or climbers—woodpecker, cuckoo, parrot.

4. *Gallinacæ, or farm yard fowls*—peacock, turkey, pheasant, pigeon.

5. *Grallæ*, or *waders*—ostrich, flamingo, heron, plover—and

6. *Anseres*, or *web-footed*—pelican, petrel, cormorant, albatross, gull, wild goose and duck, domestic goose and duck.

1. *Reptiles* are divided into the *Chelonia*, or Tortoises. 2. *Sauria*, or lizards. 3. *Ophidia*—serpents. 4. *Batrachia*—frogs.

Fishes are divided into the Cartilaginous and Bony.

The *Molluscous* division embraces the snail, slug, natutilus, and the testaceous tribe, as oyster, and all the bivalves.

The *Articulated* includes insects: the crustacea, (lobster and crab) spiders, the earth worm, leech, &c. are of this class.

The *Radiated* embraces the Zoophytes—as the infusoria, polypus, sea anemone, &c.

A brief sketch of the more prominent peculiarities of the different animals may be given under the head of nutrition,—respiration,—and the possession of the different senses, and arrangement of the nervous system.

In the *radiated* or *zoophytes*, among which we find the polypi and intestinal worms, there is little else but a simple sac without outlet, and in some a mere moveable and sensible pulp—by which nutrition is, as it were, performed by imbibition. In some of the orders, the surface is furnished with numerous small tubes, by which absorption goes on (Asteria, or Sea Stars.) Ascending in the scale, we meet with the Articulated Animals, in some of which, the *Annelides*, as earth worm, there is a simple strait and somewhat wrinkled intestine; and in the leech this intestine has two cœcums, in which the blood, sucked by the animal, will be preserved red and unaltered for many weeks. In the next class of the Articulated Crustacea, as in the families of the crab and lobster, the stomach is armed internally with five bony and dentated pieces, by which the trituration of the food is completed. Here we begin to have a more complex apparatus, and in addition to the intestinal canal there is a liver. In some of the families there is a number of lobes arranged along the intestine on each side, which seem to hold the place of livers.

The *Arachnides*, or third class of the articulated animals, as the spiders, have a strait intestine and a double stomach; the first consisting of several sacs; the second is a dilatation, surrounded by the liver.

In the next grand division of the ascending series, or the *Molluscous*, we see in the acephalous testacea, as the oyster, two stomachs; the second of which is encompassed by the liver, which empties its bile into the latter by numerous small orifices or pores.

A membranous stomach, and a gland interwoven with the liver and pouring out a peculiar liquor near the anus, are characteristic of the *gasteropodes nudibranchi*, and some other animals of this division; while certain of them have a stomach lined with a fleshy ring, armed internally with horny and cutting plates, like knives. Others, again, have four stomachs, the second of which is fleshy, and sometimes furnished with

bony pieces, while the third is supplied internally by longitudinal projecting plates. In some kindred beings in the same order, we observe a large crop leading to a muscular gizzard, armed internally with cartilaginous and pyramidal bodies—this opens to a third furnished with sharp hooks, and thence to a fourth resembling a cœcum—the intestinal canal is voluminous.

The stomach of the snail and of the slug, a family of the Mollusca, is simple, long and membranous—while in some of the other insects with shells of the same order, it is a muscular gizzard adjoining a crop. These live on herbs and grain.

Of the digestive organs of Fishes, it is sufficient, at present, to say that the stomach and intestines are mostly membranous—the pancreas often wanting, and its place supplied by cœcums of a peculiar tissue.

As regards the *Reptiles*, among the *Batrachia*, or frog family, the intestines at first very long, thin and rolled in a spiral fashion, in the tadpole, become shorter and are expanded into the necessary swelling for the stomach and colon, in the frog.

The turtles, *Chelonia*, another family, have a strong and single stomach ; their intestines are without cœcum.

If, next, we inquire into the varieties in the *respiratory organs*, we find these very numerous. In the radiated or zoophytic animals, respiration or an analogous process would seem to be performed entirely at the surface of the body.

Among the articulated animals, the leech, (*hirudo*) has no apparent organ of respiration, and the skin or entire cutaneous surface, is that part by which the process is accomplished.

In insects, properly so called, there are no lungs, respiration is performed by the intervention of the air through orifices on the surface; stigmata open into the tracheæ or tubes, the two principal of which extend in a parallel course the whole length of the body. These stigmata are in number 18 in most of the insect tribe—in the myriapodes they are more than 20, and in some of these are hardly visible.

The *Crustacea*, as the crab and lobster, breathe by means of gills which are generally attached to their feet—the same provision is made also for most of the molluscous testacea, as the oyster, clam and muscle. Such likewise, with certain modifications, is the arrangement of the respiratory organs in fishes.

In *Reptiles*, the lungs are mainly simple membranous sacs, imperfectly supplied with blood. In the crocodile, chamelion, lizard, the extent of the pulmonary membranes is, as already remarked, very great. In the Batrachia, or frog family, we find this peculiarity, that the young tadpoles breathe by gills ; while the adult animal in frogs breathes by lungs. In winter the frog is buried in the earth, or sinks under water, where it remains with little respiratory effort during the whole time—but at other seasons if prevented for a few minutes from breathing by not allowing it to close its mouth it soon dies.

We ought to have mentioned that certain aquatic worms, called from a resemblance of their tails to those of rats, rat-tailed worms, receive air by this extremity which is tubular, and which they have the power of elongating at will.

As regards the possession of the different *senses* in the several classes of animals, we cannot conceive that the zoophytes have more than that of touch. In insects generally, the organ of vision is merely an assemblage of smooth eyes resembling small grains.

In the Mollusca the only recognizable senses are those of smell and taste, and even these are often wanting. There is but one family which has the organ of hearing ; though as the animals of this tribe seem to possess the sense, it has been thought that the skin, very sensible and moist, performs this function.

The various degrees of development of the nervous system in animals, is worthy of attention. Its intimate structure would seem to be minute globules or corpuscles sur-

rounding a transparent matter. These according to Dutrochet, are to be detected in vegetables, especially those of the mimosa tribe.

The simplest example of *nervous arrangement* in animals, is in some of the mulluscous class—snail and slug. Their corpuscles are united by very fine threads or filaments.

In some insects we find one or two cords running the whole length of the animal; in others slight bulgings at regular intervals, from which radiate small twigs to the organs of movement and the viscera. The crustacea in the same class, such as the lobster, show these enlargements—the uppermost one of which, that in connexion by means of nervous filaments with the eye and other senses, is rather larger than the others.

In the vertebral animals the longitudinal cord is supplied by a mass of some size, consisting of two equal and symmetrical parts joined in one, and inclosed in a bony case, called spine—hence the name of this nervous mass is spinal marrow; from it diverge cords or nerves, connecting it with the organs of motion and sensation. At its upper extremity it is continuous with a larger and expanded nervous mass called brain or encephalon—this is also inclosed in a bony case, called cranium or skull.

In addition to those masses and their nerves, is another series of cords, passing through or converging to smaller masses or ganglia. This last division constitutes the system of the great sympathetic, which though connected with the first, or cerebro-spinal, does not acknowledge an immediate dependence on it.

D. (Page 76.)

The following extracts from Magendie's treatise, referred to in the text, may be appropriately introduced here:—

Of the Mechanism of Vision.—To facilitate the explanation of the manner in which the light enters the eye, let us suppose a single luminous beam, passing from a point placed at one end of a straight line, which will pass through the antero-posterior axis of the eye. We perceive at once that there is no other light, but that which falls upon the cornea, that can assist in vision. That which falls upon the white of the eye, the eye-lashes, or the eye-lids, can evidently contribute nothing to this effect. It is reflected differently, from different parts, according to the colour. The cornea itself does not receive light through its whole extent, for it is, in general, partly covered above and below by the open edges of the eye-lids.

Uses of the Cornea.—As the cornea is highly polished at its surface, the moment the light arrives there, a part of it is reflected, which contributes to give brilliancy to the eye. It is this which forms the images we observe on the cornea, as it then performs the office of a convex mirror. The form of the cornea shows the effect it must have upon the light which enters into the eye; in consequence of its little degree of thickness, it causes the rays of light to converge a little toward the axis of the beam. In other words, it increases the intensity of the light which penetrates into the anterior chamber.

Uses of the Aqueous Humour.—In traversing the cornea, the rays of light have passed from a rarer into a denser medium, consequently they are drawn towards the perpendicular. If they passed out into the air, instead of entering the anterior chamber of the eye, they would be refracted from the perpendicular, which they had before approached, and, of course, would return to their first degree of divergence. But they enter into the aqueous humour of the eye, a denser medium than the atmosphere; and

are, therefore, less refracted from the perpendicular, and of course diverge less, than if they had returned into the air.

Of all the light entering into the anterior chamber of the eye, that which passes through the pupil alone assists in performing the function of vision. All that falls upon the iris is reflected across the cornea, and enables us to distinguish the colour of the iris. The light does not undergo any new modification in passing through the posterior chamber of the eye, as the medium is still the same.

Uses of the Crystalline Humour.—It is in passing through the crystalline humour that light undergoes the modification which is most important in the function of vision. Physicians compare the action of this body to that of a lens, the use of which is to collect together the rays of light upon a certain part of the retina. But as it is very nécessary that the crystalline humour should have the lenticular form, we shall confine ourselves to simply announcing this commonly received opinion; observing, at the same time, that it is highly important that the subject should be further investigated. *All that can be said positively on the subject is*, that the crystalline humour must increase the intensity of the light which it directs to the bottom of the eye, in a much greater degree, from the circumstance of the posterior being more convex than the anterior surface. It may likewise be added, that the light which passes near the circumference of the crystalline humour, is probably refracted differently from that which passes through the centre. Of consequence the dilatation or contraction of the pupil, must have an influence upon the mechanism of vision, which appears to deserve attention.

All the light that strikes on the anterior surface of the crystalline, does not pass into the vitreous humour, but is partly reflected. A part of this reflected light returns through the aqueous humour and cornea, and contributes to form the brilliant appearance of the eye; another part strikes upon the posterior surface of the iris, and is absorbed by the black matter which is found there. It is probable that some degree of reflection is produced by each of the laminæ forming this humour.

Uses of the Vitreous Humour.—The vitreous humour possesses a less degree of refracting power than the crystalline; of consequence the rays of light which, after having traversed the crystalline, penetrate into the vitreous humour, are drawn from the perpendicular at the point of contact. Its use, then, as respects the direction of the rays in the eye, is to diminish their convergency. It may, perhaps, be said that nature might have arrived at the same result, by diminishing the refractive power of the crystalline humour. But the presence of the vitreous humour in the eye has another and more important use; it is to allow a sufficient extent for the expansion of the retina, and thus greatly to extend the field of vision. What we have thus said of a beam of light passing from a point placed in a prolongation of the antero-posterior axis of the eye, will apply with equal truth, to beams passing from every other point, towards the eye, with only this difference; that, in the first case, the rays tend to unite at the centre of the retina, while, in the other instance, they have a tendency to unite at some other point, according to the direction from which they proceed. Thus, those which pass from below, upwards, unite at the superior part of the retina, and those which come from above, unite at the inferior part of this membrane. The rays of light thus form, at the bottom of the eye, an exact representation of each of the objects which are placed before it, but with this difference, that the images will have a position the reverse of the objects they represent.

Motion of the Iris.—Some assert that the pupil varies its dimensions according to the distances of objects; but this point cannot be considered as satisfactorily ascertained. The only circumstance which can be considered as fully established, in the motion of the iris, is the influence exerted upon it by the intensity of the light.

Uses of the Choroid Coat.—The principal use which this serves in vision, is absorb-

ing the light, immediately after it has passed through the retina, by means of the black matter with which it is impregnated. The effects found to be produced by a varicose state of the vessels of this membrane, must be considered as a confirmation of this opinion. In those individuals who are affected by this disease, the dilated vessels remove the black matter with which it is covered, and every time the image of the object falls upon that point of the retina which corresponds to these vessels, the object appears to be spotted red. The state of vision in certain white animals, and in albinos, where the choroid coat and iris are not coloured black, strongly sustains this assertion. In them vision is extremely imperfect during the day, so that they can scarcely see how to direct themselves.

Uses of the Ciliary Processes.—There have been no opinions advanced concerning the use of these parts, but what are extremely vague and unsatisfactory; they are generally believed to be contractile. Some suppose that they are destined to move the iris, and others to move forward the crystalline humour. M. Jacobson asserts that their use is to dilate the openings which, according to him, the canal of Petit presents anteriorly, for the purpose of allowing the aqueous humour to enter, or be discharged from this canal, which would have the effect to displace the crystalline lens. Some persons imagine that the ciliary processes are secretory organs for the production of the black pigment found on the posterior surface of the iris, and on the choroid coat, or even of a part of the aqueous humour. Mr. Edwards, in a Memoir on the Anatomy of the Eye, asserts that they contribute chiefly to the secretion of the aqueous humour, an opinion before advanced by Dr. Young, secretary to the Royal Society of London, in the Philosophical Transactions.

Action of the Retina.—If we speak here singly of the action of the retina in vision, it is only to facilitate the study of this function. In reality no distinction exists between the action of this membrane, and that of the optic nerve, much less of the sensorium. The action of the retina is a vital action, and its mechanism is completely unknown. The retina receives the impression of light, when it exists within certain limits of intensity. A weak light makes no impression upon the retina, and a very strong light disables it from acting. When too brilliant a light strikes suddenly upon the retina, the effect produced is called *dazzling;* and the retina remains for some moments afterwards incapable of perceiving the presence of light. This effect is produced by looking steadily at the sun. When we have remained a long time in darkness, even a weak light dazzles us. If the light which falls upon the eye be extremely weak, and if we still endeavour to examine objects, the retina becomes very much fatigued, and we soon feel a sensation of pain in the orbit, and even in the head.

We are enabled to distinguish, with great accuracy, the direction of the light which is received upon the retina. We believe instinctively that the light passes in a right line, and that this line is a prolongation of that pursued by the ray, which has entered the cornea. Whenever the light, before arriving at the eye, has been modified in its course, the impression produced upon the retina is inaccurate. This is a principal source of those illusions which often take place in vision, and which are therefore called *optical illusions.*

The retina may receive at the same time impressions over its whole extent, but then the sensations which result from it are very imperfect. It can only be strongly affected by the image of one or two objects, although a much greater number are painted there.

The centre of this membrane appears to enjoy a more exquisite sensibility than its other parts. It is on this part that we receive the image, when we wish to examine an object with attention.

Action of the Optic Nerve.—There can be no doubt that the optic nerve transmits to the brain, instantaneously, the impressions made upon the retina by the light; but we

are absolutely ignorant of the mode in which this is done. The manner in which the two optic nerves run together, near the sphenoid bone, without doubt, must have a great influence upon the transmission of impressions received by the eyes. But it is not easy to decide, among the various opinions which have been advanced on this point, which is best, as they all have some degree of probability.

Action of both Eyes.—Notwithstanding what has been said at different periods, and the efforts which have of late been made by M. Gall to prove that we only see with one eye at a time; it appears to me to be demonstrable, not only that both eyes concur at the same time in vision, but that it is absolutely necessary that they should act thus for the perfect performance of certain important acts of this function. There are however circumstances in which it is convenient to employ but one eye. For example, when we wish to judge correctly of the direction of light, to take aim with a gun, or to ascertain if bodies are on a level, or in a right line. There is another situation where it is convenient to employ but one eye; it is when the two organs are unequal, either in refractive power or sensibility. It is for the same reason that we shut one eye, when we look through a magnifying glass.

But with the exception of these cases, it is much more effectual to use both eyes at the same time.

E. (Page 91.)

In his account of the external senses, the author has very properly stated, that each of those denominated special,—as sight, hearing, smell and taste, are supplied with nerves, the exclusive office of which is to transmit to the centre of perception the peculiar sensation, by which the sense is characterized. But whether, at the time he published the present treatise, he was unaware of, or unwilling to credit, the influence of the fifth pair of nerves, over the function of the organs of sense to which we have just alluded, it is certain that we find no reference to it in the text. It is on this account that we propose to lay before our readers in this place a summary of the state of knowledge on this interesting point of physiology.

It is usually believed in England and this country, that the discovery of the real functions of the fifth pair should be ascribed to Mr. Charles Bell and the late Mr. Shaw; but a more extended research has enabled us to ascertain that M. Bellingeri of Turin, in an inaugural essay, published in August, 1818, anticipated by three years the former of those writers, and presented an interesting account of the anatomy and physiology of the nerve in question;—an account that differs but slightly from that subsequently presented by Mr. Bell, and other physiologists.

From his experiments and researches, M. Bellingeri concludes, that the large branch of the fifth pair, is appropriated to the organic and instinctive functions as well as to the involuntary movements of the parts it supplies with twigs; while the smaller branch presides over the movements that are at the same time voluntary and instinctive. The former of these branches also exerts an influence over the sense of taste and that of touch of the various parts of the face and the interior of the nostrils; while the second is invariably a nerve of motion. Mr. Bell and Mr. Shaw, who followed next, showed by means of experiments, that the main branch of the fifth pair, in opposition to the portio dura of the seventh pair, which is a motor nerve, imparts sensibility to the head and face, to the skin, to the surfaces of the eye, the cavities of the nose, mouth and tongue, and to the skin of the lips; while another and smaller branch transmits to the muscles of those parts the stimulus necessary to elicit their contractions, when-

ever these have for their object the act of mastication. After the division of this last mentioned branch in animals, the muscles in question were found to be paralysed, and the state of flaccidity and inaction observed in them extended to the masseter and temporal muscles, which receive filaments from the fifth pair. It is to be remarked, that although the above muscles are paralysed in what relates to the action required for mastication, they do not lose, by the operation to which we have alluded, the susceptibility to contraction whenever their assistance is required for the execution of those acts necessary for the expressions of the countenance or the process of respiration.

The experiments which led M. Bell and M. Shaw to these conclusions, were soon after repeated and varied by M. Magendie and M. Serres. From them (and from some that have been performed since by other physiologists) it results, that after the section of the fifth pair of nerves, the senses of sight, smell and taste, (and M. Magendie thinks of hearing also) are destroyed, or at least greatly enfeebled on the side on which the operation has been performed. The surface of the eye loses completely its sensibility and can be touched with impunity. The cornea on the side affected becomes opake, the iris inflames, the anterior chamber is filled with purulent flocculi or false membranes,—the eye becomes ulcerated, and is finally destroyed. The tongue not only loses its sensibility but assumes a whitish appearance, the gums separate from the teeth, and the teguments of the face lose their sensibility.

Neither M. Magendie, nor M. Serres, allude expressly to the effects of the section of the fifth pair, on the movements of the muscles of the face. The former merely states that the movements of elevation of the lower jaw ceased after the operation. From their silence on the subject, we may infer that the above physiologists have not witnessed the phenomena of paralysis mentioned by Mr. Bell and Mr. Shaw.

M. Mayo regards the large branch of the nerve to which we refer, as presiding over the sensibility of the parts to which it is distributed; and the smaller branch as that destined to impart a contractile power to the muscles in which it ramifies.

If we admit the correctness of the results obtained in the experiments of MM. Magendie and Serres, the fifth pair must be regarded as the accessory nerve of all the special ones appertaining to the senses. In support of the inferences drawn by these writers, several pathological facts of more or less value have been adduced; but none, so far as we know, appears to be more conclusive than one recorded by M. Serres. In this case the loss of the senses on one side resulted from an affection of the gasserian ganglion of the same side. The patient had been afflicted with epileptic fits; and his eyes, for the last six months, had been the seat of inflammation. The pupil was contracted, the lens opake, the conjunctiva insensible to the irritation of a feather, and the nostril of the same side had likewise lost its sensibility. The sense of taste had been lost during that time;—the gums were spongy, dark coloured, and detached from the bone; the hearing was very obtuse on the right side; the patient could chew perfectly well.

On dissection, the fifth pair was found remarkably altered. At its origin the nerve was soft, of a yellowish colour, and reduced almost to a jelly. This derangement could be traced two lines into the tuber annulare. The nerve in its course forwards, as well as the gasserian ganglion exhibited the same soft yellowish appearance, excepting the muscular portion, which retained its natural aspect. The diseased nerve was considerably less in diameter than that of the opposite side.

Mr. Bell who gives a summary of this case in the appendix to his work on the nerves; and who doubts the correctness of the theory of Magendie and Serres, respecting the influence of the fifth pair over the external senses, makes a long comment on the fact in question, and on the deductions that have been drawn from it. From this we may derive some light respecting his views on the subject of the functions

of this nerve. Mr. Bell states in relation to the discovery claimed by Magendie, that nothing could be less founded in reason; that were it correct, it would be a severe blow to the student of anatomy, who traces the optic nerve into the eye, the olfactory nerve to the membrane of the nose, and the auditory nerve to the cavities of the ear. But what availed of all this, he exclaims, if the French physiologist had proved instead of the first, second and seventh nerves, that the fifth was the nerve of smelling, seeing and hearing? Mr. Bell remarks, that the fifth nerve, bestowing sensibility, and sensibility being the safeguard upon the organs, we cannot be surprised that these organs should in the absence of their natural guardian be irritated and inflamed, and consequently, deranged by the disease of the fifth nerve. This he thinks is especially true of the eye; for when the sensibility is withdrawn from that organ, the apparatus by which it is protected is useless, and the eye becomes inflamed by irritation. He reverts to his opinion relative to the difference between the sensibility of the interior membrane of the nose, and the power of smelling; the one depending upon the fifth, and the other upon the first nerve, and expresses the belief, that the common sensibility of the nostril is that which excites to sneezing and blowing the nose, and that these actions are to the nostrils, what winking is to the eye,—the means of removing whatever is irritating or offensive.

But however much we may value the opinions of Mr. Bell, we find so many physiologists in favour of the opinion of Bellingeri and Magendie, that we are disposed to attach more importance to it than the English physiologist evidently does. We are the more inclined to do this from an examination of the office which the fifth pair of nerves appear to fulfil in the lower orders of animals, and of their influence in anomalous cases. The following extract from a physiological lecture delivered before the medical school of Birmingham, by Mr. S. L. Parker, and recorded in the seventh volume of the London Medical Gazette, conveys useful information on this head. "All the animals comprising the four great classes of vertebrata are provided with a special and an accessory nerve for each special sense, except in one or two instances, where one sense happens to be null or rudimentary; for instance, for vision we have the optic nerve, the olfactory or first pair for smell, and the auditory or seventh pair for the apprehension of sound; but to each of these nerves is appended or added one or two branches of the fifth pair, connected with the gasserian ganglion, as an accessory organ intended to render the function more perfect and effective. In one or two animals the special nerve is wanting, the sense remains rudimentary and imperfect, and is supplied only by the first or accessory nerve. It is thus with the olfactory sense of the phoca and other cetaceous animals; the sense of smell is present, but supplied only by one or two branches of the fifth pair. In the "Sorex," or water shrew, the "Talpa vesicolor," or rat mole of the Cape, the "Zemmi," the Proteus of the subterranean lakes of Carniola, and some others, the eye is rudimentary, the sense of vision is present, though obscure, the optic nerve has disappeared from the base of the brain, and the sense is furnished with one branch of the fifth pair only. In fish, more particularly the family of the rays, the acoustic nerve is wanting, and the organ provided solely with a branch of the fifth. We thus find that as the senses become more simple they are abstracted from the influence of a special, and submitted to the imperfect action of an accessory nerve. Even in the lower vertebrata, as we have seen, this takes place; and when we come to examine the invertebral classes, we find them supplied with one nerve only for each sense; and reasoning from analogy, and from the rudimentary state of the organ performing the functions, we are led to suppose that it is the accessory nerve alone, which is possessed by all the invertebrata.

In the anencephalic fœtuses, where the brain is entirely wanting, and the bones of the head are imperfectly developed, the body of the sphenoid being also wanting, the two gasserian ganglia approach each other, and are confounded in one general mass,

with which the olfactory, optic, acoustic and other nerves of the head are joined and connected. Many such instances of monstrosity are upon record, having occurred both in man and animals, and during the life of the individual the function of vision, of taste (since infants thus deformed have taken the breast), and of hearing, have been perfect; the ganglion of the fifth pair having presided over the functions which in a normal state, are attributed only to the special nerves."

These observations, some of which are original with him, while others are due to Treviranus, Scarpa, and other physiologists, joined probably to the remark of the former of these distinguished writers, founded on extended and careful researches—"that the number of the senses with which animals are supplied is not limited to that of our own special ones; and that it is principally the branches of the fifth pair that are distributed to such of the sensorial organs that differ from our own," as well as to the pathological fact we have recorded above; all these circumstances have induced M. Serres to adopt on the subject of the functions of the fifth pair, an opinion similar to that of M. Magendie.

Some anatomists have denied not only the correctness of the inferences that may be drawn from the anatomical facts to which we have alluded, (the absence of the optic nerve in some of the lower animals) but the reality of the facts themselves. Gall, for example, examined the organ of vision of the mole, and affirms, that he found the optic nerve to exist. He admits, however, that in this animal, as in all species of rats, mice, and smaller mammiferæ, the nerve is very small. M. Bailly is said to have repeated the dissection with similar results;—a circumstance which has led writers to suspect that some inaccuracy had crept in the examination of the other animals in which the optic nerve is alleged to be wanting. Upon this subject we shall not pretend to decide positively, and must content ourselves with remarking, that the coincidence of opinion on the subject of the absence of the nerve in some of the lower animals, and of its office being supplied by the fifth pair, is so far manifest, that we would be tempted, from this circumstance alone, to lean towards the opinion of M. Serres, in preference of that of Gall and his followers, who, it may be proper to add, had a theory to support, against which the facts we have mentioned militate.

Mr. Parker thinks that the fifth nerve might be judiciously termed the sympathetic cord of the senses tending to preserve the union and consent of their actions. He asks, "what is the office of the ganglionic system, or that of the great sympathetic? Is it not to promote and preserve uniformity and accordance in the action of the viscera? Is not the action of the respiratory system of Mr. Bell, strictly confined to establishing an uniform consent in all the organs connected with the phenomena of respiration? And why should not the senses, when their numbers and functions become increased and perfected, be submitted to the presiding influence of a sympathetic nerve, whose action tends to establish and keep up a consent or sympathy in their actions? That such a presiding influence is necessary, and is present in man and animals, is evident, and could be pointed out at large would our limits permit us. Bichat has sufficiently proved it in his work on life and death. If there is not an uniform consent in the actions of the two optic nerves an imperfect image is pourtrayed on the retina, and a confused idea produced on the sensorium. It is the same with sound, odour, and taste. And this consent, accordance or sympathy, is produced, I believe, by the action of the fifth pair of nerves." Correct as the idea of the sympathy may be, we are not certain that the doctrine of Mr. Parker is correct; since Tiedemann, in an admirable essay on the influence of the sympathetic nerve on the sensorial organs, has adduced many facts, calculated to show that the branches of the ganglionic system distributed to those organs, are the instruments of the phenomena which Mr. Parker ascribes to the fifth pair.

F. (Page 96.)

An opinion similar to that of our author, in relation to the agency of the eighth pair of nerves in the process of respiration, is entertained by several physiological writers of the present day. Mr. Rolando, Dr. Philip, Dr. Alison and Mr. Brachet, have defended it with more or less zeal and ability, and have even maintained, that the office of this nerve extends to other operations of the economy, in which, as will be seen in the text, M. Broussais only admits its agency to a certain extent. According to Mr. Brachet, who is the most recent among the writers just enumerated, the par vagum presides, in the internal organs, over the sensations of which these are the seat—as for example the desire of inspiring and expiring air, the sensations of hunger, of thirst, &c. He conceives that nature has provided all the organs destined to develope sensations with cerebro-spinal nerves. Hence the lungs, stomach, and upper portion of the intestines receive branches from the par vagum, as well as from the sympathetic, while the bladder, the rectum, the uterus, &c. receive nerves from the inferior portion of the medulla spinalis, the office of which is to preside over the desires of urinating and of evacuating the fæces and over the pains of parturition. There is no doubt in his opinion, that the par vagum fulfils the same office in regard to the lungs and stomach as the spinal nerves do to the bladder and rectum; namely, that it presides over the peculiar sensations of these organs. To this opinion M. Brachet and those who entertain similar views have been led not only by the consideration of the analogy we have just noticed as existing between the various nerves with which these different organs are supplied in addition to the branches of the sympathetic nerves, which, according to these gentlemen, have special offices to fulfil, and by the experiments on the medulla oblongata cited by our author in reference to respiration alone, but also by the results of experiments on living animals. Thus it is said, if we divide the par vagum the animal no longer experiences hunger or evinces the sensation of satiety, and hence refuses to eat, or if he does eat, it is with indifference, and so mechanically, that he does not cease even after the stomach is full. He does not experience a desire to vomit; and his stomach is insensible to the action of the strongest emetic. In such cases also the desire of inspiration and expiration is annihilated;—a fact which M. Brachet endeavours to support by citing the results of some experiments made by him, in which it was found, that if dogs, in some of which both nerves of the eighth pair have been cut, while in others they are left entire, be placed under water, the last will struggle until asphyxia takes place; while the others will allow themselves to be drowned without evincing any signs of uneasiness. Finally, these physiologists remark that a lesion of the lower part of the spinal marrow destroys the sensibility of the bladder and rectum, thereby rendering these organs incapable of eliciting those sensations which have reference to their excrementitial functions.

As regards ourselves we are very far from being prepared to receive this opinion relative to the functions of the eighth pair of nerves as the most rational and correct; but we cannot help remarking, that it is preferable, in point of consistency, to that entertained by some writers, who refer one of the wants to the agency of the eighth pair, which are spinal nerves, and the others to the sympathetic. But let us proceed.

While some physiologists regard the par vagum as the sensitive nerve of the organs to which it supplies filaments, others have attempted to show by experiments that it presides over the muscular movements of the same organs. In the experiments of Legallois, a division of this nerve gave rise to such a complete paralysis of the muscles by which the laryngeal and vocal organs are kept open, that the animal always perished by suffocation unless an artificial opening was made in the windpipe and kept pervious by a tube. In the experiments of Edwards, Breschet and Vavasseur, a division of these nerves occasioned a partial suspension of the process of digestion—

a circumstance resulting from the paralysis of the muscular fibres of the stomach; and which led those physiologists to conclude that the principal function of the par vagum, at least, in what relates to the digestive apparatus, is to preside over the muscular movements of the gastric organs. In the experiments of Ware, recorded in the fifth volume of the North American Medical and Surgical Journal, a similar state of the muscular coat of the stomach was produced by this division.

If we irritate the nerves surrounding the œsophagus, the muscular fibres of the stomach and intestines are made to contract. Again, a lesion of the lower part of the spinal marrow occasions a paralysis of the muscular fibres of the rectum, bladder, and even of the uterus; none of which organs can any longer perform the functions depending on the action of these fibres.

Other experiments, for which we are indebted to Mr. Brodie, to Dr. Philip, M. Dupuy, and others, go far, it is believed, to show, that in regard to the stomach a section of the par vagum puts a stop, 1st, to the process of secretion in that organ, by which the function of chymification is suspended; the aliments remaining in it unchanged a long time, unless, as was found in some instances, galvanism be applied to the lower extremity of the divided nerve. 2d, To the process of absorption; since, according to Mr. Dupuy, we may administer without effect to animals thus circumstanced, poisons, that act by being absorbed; nux vomica, for example. In reference to the agency of the nerve in question on the function of respiration, it was found in the experiments of Dupuytren, Provençal, Rolando, Magendie, Legallois and Brachet, that hematosis was impaired soon after a section of the eighth pair of nerves had been made; the blood being no longer oxygenized, but remaining very black in the arteries, as also in the capillaries of the mucous membranes; which in consequence no longer presented a red hue.—That the air expelled had lost less oxygen, and that finally, after a longer or shorter interval, the animal died of suffocation. The results of these experiments were, it is true, denied by Emmert and De Blainville, who maintained, that the influence of the par vagum was not so great as supposed, and was even null: but they appear now to be no longer doubted.

From a review of these facts and arguments as well as from various circumstances, to which we shall have occasion to refer, we are inclined to believe, that the opinion of those who ascribe to the eighth pair a sensitive function is not fully proved, and that the true office of that nerve would seem to be to preside over the muscular actions of the organs to which it is distributed—consequently, that the views advocated by our author, and other physiologists, on the subject of its agency in respiration and digestion, would require to be modified.

1st. If the nerves of the eighth pair conveyed to the brain the sensation of the want of air, it is difficult to explain how animals in which both the branches going to the lungs have been divided, could continue to live and to breathe. It is true, that in some cases mentioned by Haighton, Béclard, &c. death immediately followed a complete section of these nerves. But in the majority of experiments performed by Dupuytren, De Blainville, Provençal, Rolando, Brachet, and others, the animals continued to live even for several days, and necessarily breathed; which implies, that the sensation of the want of air continued to be conveyed to the brain. Besides, it would follow from the experiments of Legallois, that sudden death, in many instances, resulted from the division of the recurrent nerve, or, as Mr. Hastings says, of the laryngeal nerve, and from the consequent closing of the glottis. It is true, that in some of the cases on record in which the animal lived, the two extremities of the nerves, after their division, remained in apposition; thus enabling the nervous influence to pass from one to the other; but in other instances a portion was excised from each cord, and still the animal breathed for a period varying from a few hours to several days.

Some physiologists have endeavoured to explain this by the supposition of the exist-

ence of a communication of innervation from one extremity to the other by means of the filaments of the sympathetic which accompany the par vagum. But if we admit this explanation, we necessarily admit that the sympathetic can convey sensations. Now if we do this, we can discover no necessity for referring to the eighth pair the effect in question. Mr. Brachet endeavours to explain this continuance of respiration by the force of *habit*, which causes the muscles to continue to effect automatically the movement necessary for inspiration. But respiration continues too long after the division of the par vagum to be accounted for in that way. Besides, were this force of habit the true cause of the phenomenon in question, we ought to find it operative after the division of the medulla oblongata. When the nerve is cut, the symptoms observed are those of the sensation of a want but with an inability to effect the movements of respiration, or rather to combine these movements and propel the air deep enough in the lungs. "The breathing, as Magendie remarks, is, at first, embarrassed—the movements of inspiration are more extended and oftener repeated, and the animal's attention appears to be fixed on them in a particular manner. The movements of locomotion are less frequent—they evidently cause fatigue; sometimes the animal remains perfectly motionless. The formation of arterial blood is not prevented in the first moment; but soon, on the second day for example, the difficulty of breathing becomes aggravated, and the efforts of inspiration become more and more considerable. At this period the arterial blood has lost a part of its bright red colour, its temperature decreases; finally, all the symptoms are aggravated, and breathing takes place only by means of the co-operation of all the inspiring powers; the blood becomes darker and darker—its quantity in the arteries lessens—the body becomes cold, and the animal soon perishes."

2d. It is not exactly correct to maintain, that sensations either natural or extraordinary, are not conveyed to the brain from the stomach, after the division of the eighth pair. M. Magendie relates in his work on physiology, that tartar emetic introduced into the stomach of an animal in which he divided both branches of these nerves, caused vomiting—the act being accomplished we presume by the diaphragm and abdominal muscles, in the same manner as it takes place in those cases in which a bladder is substituted for the stomach, and the emetic is injected into the veins. Vomiting is of common occurrence after the division of this nerve; and depends on the circumstance that the œsophagus being paralysed, no longer offers an obstacle to the ejection of the contents of the stomach. But in all these cases it is plain, that we must admit the existence of an irritation of the stomach prior to the contraction of its fibres and to that of the abdominal muscles; since these contractions cannot take place except as a consequence of an irritation.

In the experiments of Breschet, Edwards, Dupuy and Vavasseur, the animals continued to feel the desire for food, and even to eat considerably after the section, with loss of substance, of the par vagum. Tiedemann and Magendie obtained similar results; and Leuret and Lassaigne positively affirm, that in all their trials on horses the animal manifested considerable appetite. Mr. Swan relates, in his work on the Nerves, the case of a gentleman who died after great dyspnœa, and in whom the par vagum was found soft and smaller than usual. This patient experienced an insatiable appetite, without feeling a sensation of fulness after taking a very large quantity of food.

M. Brachet details some experiments, in which he found that after the division of the par vagum, the animal exhibited a loss of sensibility in the trachea and lungs; experiencing no sensation from the presence in those parts of foreign substances or the vapour of ammonia. He infers from these facts that the par vagum

is the nerve of the sense. But it should be recollected that this nerve in its progress to the lungs and other organs, is accompanied, as Mr. Bell states very correctly, by filaments of the spinal nerves; and that these may be divided, together with the former, and occasion thereby a loss of sensibility in the parts to which they are distributed. Besides, this sensibility is different from that on which the sensation of a want of air depends. The latter is purely organic, and may continue, as was the case in some instances we have mentioned, and even in several of Mr. B.'s own experiments, although the other is lost. But whether this loss of animal sensibility in instances of division of the par vagum, really takes place is a point which has not yet been confirmed by other physiologists.

3d. It is difficult to conceive how the same cord arising by small roots from the middle column of the spinal marrow, could be at the same time a nerve of sensation and a nerve of motion. That it is a nerve of the latter kind, has been proved by the experiments to which we have alluded;—experiments which had reference, not only to the branches furnished to the glottis; but also to those by which the lungs and stomach are supplied. Hence we may presume, that it is not a nerve of sensation; unless we abandon all our present views relative to the distinction of the functions of both sets of nerves, and to the difference of their origin.

It is right to remark, that M. Brachet, who, while contending that the par vagum is the nerve of the sense, admits that it is likewise a muscular nerve, and presides over the muscular actions of the stomach and lungs, maintains, that like the spinal nerves it has a double origin; some of its filaments which descend obliquely from the edge of the calamus scriptorius belonging to the sensitive cord, while others which arise from the olivary bodies are continuous with the motor cords.

4th. The effects of a section of the par vagum are due, as Brachet has shown, and as is believed by Legallois and Dumas; not so much to a deficiency of action on the blood as to a paralysis of the muscular fibres of the bronchia and air cells; the existence of which has been proved by Ressessein;—a paralysis preventing the expulsion of the blood and mucus which accumulate in and block up the cells and thus prevent the free circulation there of the blood sent for oxygenation.

Some physiologists, it is true, maintain that the nerves of the eighth pair are the great chemical agents in the process of respiration, and cite in support of this opinion, that these nerves always coincide in volume with the density of the medium in which the animal respires, and with the extent of surface over which the blood is distributed in order to be placed in contact with the oxygen contained in the air or in the water. Thus, it is said, the respiratory branches of the eighth pair, of fish, are the most voluminous of all the classes: the medium respired is water, the proportion of oxygen combined smaller than in the atmosphere, and the respiratory organ small. In reptiles the lung is large, the quantity of oxygen required small, and the nerve diminutive. In birds the respiratory surface is immense, the proportion of oxygen demanded, great, and the nerve small. The mammalia hold a middle rank between the two last mentioned orders.

But all that is thus supposed to favour the opinion of that nerve being the chemical agent may be brought forward in support of the idea, that it is the muscular nerve of the bronchia; since in those animals that respire in a dense medium, the bronchia may be supposed to require a greater degree of innervation; and it is difficult to reconcile this opinion with the fact, that blood placed in contact with atmospheric air out of the lungs becomes oxygenated; or with the results obtained by Dumas and Brachet, in their experiments, that when air is forcibly injected into lungs deprived of the influence of the eighth pair by division of these nerves,

the blood becomes oxygenated. Besides, were this opinion correct, it would be necessary, that the nervous fluid should be the agents. Now, although some think this is rendered probable by the circumstance, that galvanism may be substituted for the fluid in question; yet it is disproved by the experiments of Breschet, in which the irritation of the nerve by mechanical means, produced in reference to the digestive organs, the same effects as galvanism and electricity.

It may be asked, if the par vagum be a nerve of motion, and as such preside over the muscular movements of the lungs, how comes it that the presence of mucus in the bronchia and trachea, after its division, causes no cough;—a fact remarked by Brachet, and which he has adduced in favour of the opinion of that nerve being sensitive as well as motor? We answer, because the filaments, which impart animal sensibility to the lungs, have probably been divided; and, because the bronchia, being paralysed in their muscular action, become filled with blood and mucus, which compress the sensitive nerves, admitting that these are not injured, and benumbs them. The same occurs in some forms of pneumonia.

5th. We doubt whether the secretions of the stomach can be said to be under the special control of the 8th pair of nerves, and whether the opinion of De Blainville, Legallois and Philip, that the digestive process is entirely suspended by its division, can be regarded as correct. So far as we can discover, the only reason alleged in favour of the idea of this agency of the par vagum over the secretory process in question, is that the aliments, received in a stomach deprived of the peculiar innervation supplied by that nerve, remain there for a long time nearly unaltered. That the secretions may be in some measure modified by such an operation, is not matter of astonishment, for there is between the various parts of the nervous systems and other organs, a consensus from which results a modification in the function of one of those parts, when the other is affected by disease or injured mechanically. But this does not prove, that this portion of the nervous system is the one charged specially with the agency of the function of the organ whose action is modified. We may, in this way, account for the fact, that Tiedemann and Gmelin, while advocating, with others, that the secretory process of the stomach is under the control of the ganglionic system, mention, that in animals subjected to the division of the eighth pair of nerves, they found the gastric juice of an alkaline quality. Our countryman, Dr. Ware, found the secretion increased in quantity, though, as he affirms, of a morbid kind. Yet, in a great number of experiments, chyme was discovered formed on the surface of the alimentary mass. Thus, professor Mayer, after the ligature of the nerve, found that the chemical act of digestion continued to be effected. M. Brachet makes the same remark. In the experiments of Magendie, as well as in those of Breschet, Edwards and Vavasseur, chyme was found in considerable quantity, when the nerves were simply divided, and in smaller quantity when the nerves were divided with loss of substance. In the latter case it was only found on the surface of the alimentary mass. In his essays on the nervous system, Mr. Shaw has offered, in opposition to the supposed special influence of the par vagum over the secretion of the stomach, some remarks of the highest interest, and which nothing but the want of space prevents us from transcribing here. They are founded on the anatomical distribution of the nerves, and the independence of them, in some classes of animals, of the stomach. From a consideration of all these facts we may conclude, that the par vagum is not specially entrusted with the power of secretion; since the formation of chyme, however limited it may be, in animals deprived of the par vagum, proves that the secretions of the stomach continued to be effected.

The diminished formation of chyme, in those cases, can be accounted for more readily on the supposition—or rather by the fact, for it is a fact,—that aliments, placed in a stomach, so circumstanced, and the muscular coat of which is paralysed by the division of the nerves, cannot be subjected to the degree of motion required for bringing all their particles in contact with the secreting surface. We all know that chymification does not require the action merely of the gastric fluid, but also the mechanical action of the stomach, by means of which the motion, we here alluded to, is effected.

While on this subject, we may remark, that if the division of the nerves of the eighth pair impeded the process of digestion, in the way meant by Mr. Brodie, it would do so by preventing the transmission of nervous power from the centre. In this case, we would be obliged to cease regarding these nerves as sensitive, unless they can be conductors to and from the stomach. Now, as we have reason to believe they are not endowed with this double office, it follows, that even if we admit the views advocated by Mr. Brodie, the doctrine, which ascribes to this nerve the office of conveying sensation to the brain, must be abandoned as incorrect.

6th. In cases in which galvanism is applied to the extremity of the divided nerve, and occasions a renewal of the digestive process, it produces this effect, we believe, by exciting *de novo* the muscular action of the stomach, so necessary for chymification; rather than by merely influencing the secretion of that organ, since the muscular coat of the latter is paralysed and remains so, unless the nerve by which it is supplied with innervation, be excited by some means or other.

These experiments, which were originally made by Dr. Wilson Philip, and repeated by him in presence of the committee of the Royal Society, have also been made by Clarke, Abel, Hastings, Breschet, Edwards, and Vavasseur, and almost invariably with similar results. That galvanism acts in the way we have mentioned, we infer from the fact, that when applied to the branch supplying the lungs, it restores the function of respiration, which had been suspended by the division of the nerve. Here there is no gastric juice to secrete, and the mode of operation of galvanism, is evidently to renew the contractile power of the lungs destroyed by the section of the nerve. This is further demonstrated by the fact, that mechanical irritation of the nerve gives rise to the same result. Dr. Ware doubts the correctness of the conclusions to which Dr. Wilson Philip was led by the results of his experiments, but the error is probably on his side; since Dr. Philip is supported by Breschet, and Mr. Broughton himself, who at first opposed the correctness of the experiments in question, was led to a change of sentiment, when he saw them repeated by Dr. Philip.

7th. In those very cases in which galvanic or mechanical irritation is applied to the extremity of a divided pneumo-gastric nerve, we notice some circumstances which lead to a knowledge of the true function of that nerve.

The wire, in such cases, has been applied to the lower end of the cord; and the current of fluid has been directed downwards towards the stomach and lungs, whose muscular coats are thereby excited to action. Now, if the office of the nerve were to convey sensation to the brain, no such effect would be obtained; since it would have no influence on muscular fibres. If we try the experiment on other spinal nerves, we shall find that it is only the lower extremities of divided muscular cords that convey the galvanic current downwards; these nerves do not convey it upwards, and the sensitive branches, when divided, only convey it in that direction, and not downwards. In other words, we are not aware that we can occasion a sensation in the brain, by galvanizing the upper extremity of a divided

muscular nerve, or muscular contraction by galvanizing the lower extremity of a divided sensitive nerve. And yet this would be the case were the par vagum a sensitive nerve, unless we admit that it is at the same time a sensitive and a motor nerve. But in that case we should be forced to admit that such a nerve could arise from the same part of the spinal marrow, as other respiratory nerves which are allowedly motor. We are not aware that the experiment of galvanizing the upper extremity of the divided par vagum has as yet been made, but *à priori* we should not anticipate the transmission of a sensation to the brain, either similar to that of hunger, or to that necessary for eliciting the movements required for the ejection of any substance from the stomach, or for the inspiration of air into the lungs.

8th. The result of the experiment by dividing the medulla oblongata, in putting an immediate stop to the process of respiration, is easily accounted for, when we bear in mind, that all the muscles required for expanding the chest and thereby enabling the lungs to receive air, are paralysed. Now, even admitting that the sensation of a want of air is felt;—which we cannot do, since the point of the encephalic mass, which receives sensations from all parts of the body, is destroyed, still no command for the execution of the necessary muscular movements of the chest can be transmitted. But allowing that this command is transmitted, the movements could not be executed, since the agents of transmission have been destroyed at their very origin. If artificial respiration be resorted to, the thorax is dilated, the muscles, which expand the chest, retaining still a portion of their contractility, aided by the stimulus of arterial blood which continues during sometime, though imperfectly, to be formed and is sent to them by the circulation;—a function in a great degree independent of the spinal marrow, and continuing for awhile unimpaired;—the muscles, we repeat, are excited to contraction, and the lungs are enabled to receive the air. By the same mechanism we can explain the subsequent contraction of those muscles that diminish the cavity of the chest. But even supposing that the results of the experiments in question, were not to be explained in the way we have mentioned; we believe that those who contend that the nerves of the eighth pair preside over the sensation of the want of air, will find an equal difficulty in accounting for them. However this may be, we can hardly believe that the sudden death of the animal, in those experiments in which the medulla is destroyed, is to be ascribed simply to the division of the par vagum; or that from such an effect, we are justified in concluding, that this nerve is the conveyer of the sensation of the want referred to; since we are not at all sure it is a nerve of sensation, and it often happens that its division after it has emerged from the cranium is not followed, until a few days after, by death.

Some writers have objected to the view here taken of the functions of the par vagum;—viz. its presiding over the contractile action of the muscular plane of the lungs—that the general rule, which nature has established, of referring involuntary muscular action, not to the cerebro-spinal, but to the sympathetic, nerves, would, in this case, be set aside; for the contractile action of the lungs is involuntary, and the par vagum originates in the upper part of the spinal marrow. But, as M. Brachet has remarked, this nerve does not reach the organs which it supplies before forming a long plexus, the only use of which is probably to weaken the nervous action of the brain, or rather to put a stop to the transmission of volition. To this may be added, that in some of the vertebrata this nerve presents a true ganglion, assumes many peculiarities of structure, and becomes, in the lower orders, in some respects *vicarious* to the sympathetic, circumstances which have led some physiologists to place it among the nerves of vegetative life. It is true, that in the

human subject the nerve in question does not assume this ganglionic appearance, but only presents a reddish spot pervading a part of its fibrils; but the circumstance of its performing important functions in animals of a lower grade than man; —of its presenting, in those animals, peculiarities of structure that approximate it to the sympathetic, as well as of its forming in the human subject a plexus, may authorize us in regarding it as a nerve, which, though spinal, is removed from the sensitive and placed in the vegetative sphere. M. Brachet who, as we have seen, refers to the par vagum the contractile action of the muscular coat of the stomach, and attributes to the plexus, which that nerve forms, its isolation from the power of the will, or, in other words, from the sphere of the nerves of animal life, attributes, nevertheless, to it the sensation of hunger and satiety. This is evidently an inconsistency, upon which his reviewers have not failed to animadvert. If the peculiarity of arrangement of this nerve, has contributed to diminish the nervous action of the brain, or rather to place it beyond the sphere of volition, in what relates to the contractile power of the muscular coat of the stomach; it ought to render it equally inadequate to the free transmission of sensations—sensations which in some cases are keen and imperious, and, under particular circumstances, even amount to pain. It is plain that in our theory such an inconsistency is avoided.

9th. The different branches, sent off by a nerve, have the same functions to perform as the nerves from which they emanate. Now, the recurrent nerve, which is a branch of the par vagum, is decidedly a motor, and not a sensitive nerve. Hence we may infer, that the par vagum itself is also a motor, and not a sensitive nerve. What the particular functions of the cardiac branch of the eighth pair are, we shall not undertake to examine. But certainly that branch has nothing to do with the sensibility of the heart. Hence the other branches of that nerve may be pronounced not sensitive. To this it may be added, that neither the recurrent nor the cardiac branches preside over the secretory process of the parts they supply, and that consequently the others are not endowed with such properties.

10th. We believe, that the view we have here endeavoured to develope, is supported by the opinions held on the subject of the par vagum by Mr. Charles Bell. We say we believe, for it is not always easy to arrive at a knowledge of Mr. Bell's opinions, and in the present case, we read the whole of his work on the nerves, without discovering one passage, in which he states, in positive terms, whether he regards the eighth pair as nerves of motion or sensation. We infer his views, however, from the context of sundry passages, and particularly of the following, which we extract from the report of a lecture, delivered by him before the Royal College of Surgeons of London.

"When there is a new class of muscles to be brought into play, proceeding uniformly in their motions, whether we are awake or asleep, which must have a perfect and independent regulation; there must be new nerves appropriated to them. This course of reasoning passing through my mind, I naturally originated the question—is it for this reason that the par vagum has so singular a course; that the diaphragmatic nerve threads the other nerves without connexion with them; that another nerve (the external thoracic) with the same origin, also passes across the axillary plexus, and takes a course upon the muscles on the outside of the chest; that the spinal accessory takes so singular and circuitous a route; and that the portio dura deviates from the direction of the fifth, and takes a course which permits its association with the nerves of respiration and speech?—Experiment decides this matter. These are the nerves which combine the various parts to which they diverge in the act of respiration; and by their division, the motion of the respective parts to which they go, are cut off from the act of breathing. And now,

when we look to their origin, we see with interest that these nerves, as far as they can be traced, come from a distinct column of the spinal marrow."

It is plain that here the par vagum is regarded as a muscular nerve and assimilated to the diaphragmatic, the external thoracic, the spinal accessory, &c. which are nerves of motion and not of sensation.

In his large work on the nerves, Mr. Bell makes the remark, that all conspires to show, that the use of the par vagum is to combine the proper organs of respiration; while the other nerves of respiration are to draw the external apparatus of muscles into sympathy with the heart and lungs. Again: "Comparative anatomy would lead us to infer that this nerve is not essential to the stomach, as it does not exist but where there are heart and lungs to associate with a muscular apparatus of respiration. That the stomach must be associated with the muscular apparatus of respiration, as well as the lungs, is obvious, from the consideration of what takes place in vomiting and hiccough, which are actions of the respiratory muscles excited by irritation of the stomach."

Mr. Bell admits, it is true, that "the peculiar sensibility of the stomach, larynx and pharynx, is bestowed, as well as the arrangement of the muscles, through the influence of the par vagum and its branches;" but he adds, that "this double office proceeds, in all probability, from its receiving additional branches from the spinal nerves, just as it is emerging from the base of the skull." (Appendix to his work on the Nerves, p. 131.) It is proper to state, besides, that Mr. Bell refers to a case in which sensibility was manifested by pressure at the scrobiculus cordis, while other parts were paralysed and insensible. It is plain then, that he meant animal sensibility, and not the peculiar sensibility which is the agent of the sensation of the wants.*

* Since writing the preceding note, we have read Dr. Calvert Holland's "Experimental Enquiry into the laws which regulate the phenomena of Organic and Animal Life," as well as his work on the physiology of the Liver and Spleen. This ingenious physiologist remarks, in reference to the experiments of Dr. Philip, that they show that digestion ceases when the eighth pair of nerves is divided; but that as circulation and respiration are extensively influenced by this operation, it cannot be doubted, that this physiologist has remarked the functional disorder produced, and ascribed it, without due consideration, to the immediate loss of nervous energy belonging to the stomach. He maintains, that the principles which Dr. Philip deduced from his experiments, are fallacious, from the circumstance, that in experiments of his own, it was found, that the division of the nerve in question, is injurious to the digestive powers of the stomach, in proportion only to the disorder induced in those of respiration and circulation—and that when these were protected by the introduction of a small tube into the divided trachea, which enabled the animal to breathe with facility, digestion proceeded as correctly, although a portion of the nerve on each side was excised, as when the nerves were left entire, the trachea alone being separated, and a tube attached, as in the preceding instance.

These experiments of Dr. Holland, confirm a fact already known, and which is mentioned in the text of this appendix—i. e. that respiration continues, after the division of the par vagum, when care is taken to enable the air to penetrate into the lungs. They prove, therefore, that these nerves are not the conveyers of the sensation of the want of air. They confirm also the fact, that these nerves do not convey the sensation of the want of food, and do not preside over the function of secretion in the stomach. But Dr. Holland should have stated how long the functions of respiration and digestion continued, after the section of the nerves. Now we know from the experiments of Legallois, that animals placed under these circumstances died after a few days, and in a way to which we have already alluded, and we may presume the same occurred in the trials of the former. Be that as it may, Dr. Holland's experiments only tend to confirm the views we have developed in this appendix, respecting the agency of the eighth pair in respiration, for he states, that the par vagum, is evidently a nerve of respiratory motion; and concludes, from his interesting and numerous experiments, that the function of this nerve, and of its various branches, is to regulate the ingress and egress of atmospheric air in the act of respiration. As regards the results obtained by Dr. H. in reference to the digestive process of animals subjected to the experiments in question, we are inclined to believe, he has expressed himself too strongly; and that though digestion may continue to a certain extent, it does not proceed as regularly and particularly with as much rapidity, as when the nerves are left entire.

G. (Page 99.)

Assuming, with M. Broussais, the superior part of the medulla oblongata to be the centre of the nervous system, we find the superior and anterior portion of this system constituting the encephalic, and the inferior and posterior the spinal region.—Each of these has its series of functions, or rather, the office of exciting or governing other functions.

The nervous apparatus, constituting the encephalic region, were almost entirely unknown, in their structure and functions, before the times of Gall and Spurzheim. By their labours, and by those of their rivals and opponents, the latter often entered into with the express purpose of contradicting the inferences from the former, physiology and mental philosophy have gained immensely. It is now generally, if not universally admitted, that the superior part of the encephalic region, or the lobes, are the organs of the various faculties constituting mind; in other words, that the propensities, emotions, and intellect, are displayed by means of the material organs consisting of the encephalic lobes. The lower part, or basis of the encephalon is in more immediate connexion, in structure and function, with the nerves of the senses, commonly so called, and the motor organs of the extremities.

The portion of the nervous mass and system, generally inferior to the central point at the medulla oblongata, is the spinal. It also consists of a congeries of organs, or parts, each having its particular function. These may be considered in two ways—longitudinally and horizontally. Regarded in the first light, we have two symmetrical halves joined at the medium line—each exhibiting precisely identical appearances and functions. If, however, we examine one half separately, we shall find that the roots of the two lateral nerves, which it gives off, the anterior and posterior, have different offices, and that the longitudinal tracts, corresponding with these roots, also differ in their properties—the anterior tract and the nervous root, giving to the parts, which are supplied by the nervous cord, and its ramifications, the property of motion—whilst the posterior tract, and its corresponding nervous root, cord, and branches, confer the property of sensibility on the parts to which they are distributed.

If we examine into the offices, performed by the several parts of the spinal portion of the nervous system, divided horizontally, we discover that each particular part, beginning from the medulla oblongata and going down to the lumbar section, has a direct relation with the splanchnic viscera, as either governing or exciting them to functional effects, composed of sensation and motion.

The several parts of the encephalic spinal nervous mass, to which we have thus cursorily adverted, are spoken of by M. Serres as exciters to the particular functions. The phrase is, perhaps, not a very happy one, for however we may admit that certain portions of the brain and spinal marrow, are exciters to the locomotive apparatus, we cannot, as he does, speak of the cerebral lobes being exciters to the intellectual faculties—they being, in fact, the organs themselves of these faculties. The following summary of the conclusions at which M. Serres has arrived, may serve to aid the memory of the reader, without his being pledged, however, to an admission of their entire accuracy:

"1. The inferior enlargement or bulging, that is, the lumbar region of the spinal marrow, is the exciter of ejaculation and contraction of the uterus, bladder and large intestine.

"2. The dorso-costal portion is the exciter of the small intestines and the movements of the ribs.

"3. The cervical region is the exciter of the mechanical agents of respiration, and particularly of the diaphragm.

"4. Moreover, the anterior cords of the spinal marrow seem to be the *chief exciters of movements*, and the posterior cords the *principal exciters of sensibility*.

"5. The basilar segment is a centre of excitation. The olivary body is *the exciter of the movements of the heart;* the restiform body *the exciter of pulmonary respiration*. The cord which separates these two bands is *the exciter of the stomach*. The excitations of preservation and nutrition are thus concentrated in the inferior limits of the segment, (*Organ of nutrition of* Willis.)

"6. The superior part of the segment is *the exciter of general sensibility and mobility*. (Lorry.) The trapezium is *the exciter of the movements of the face*. The bands in which the trigeminal nerves are inserted are *the exciters of the apparatus of the senses and of instinct*.

"7. The quadrigeminal bodies, regarded by Willis as the *organs of preservation*, are *the exciters of the association of voluntary movements* or of *equilibration*, and also the *exciters* of *the sense of sight* in the three inferior classes of animals.

"8. The median lobe of the cerebellum is *the exciter of the organs of generation*. Its hemispheres are *the exciters of the movements of the limbs*, and more especially of the pelvic members. The cerebellum is *the exciter to jumping*.

"9. The optic bed is the exciter of sight in man and the mammifera. Its radiations are *exciters of the movements of the thoracic* or *upper extremities*, and subsidiarily *exciters of respiration*.

"10. The radiations of the striated body are *exciters of the pelvic members*.

"11. The olfactory field is *the exciter of the sense of smell*.

"12. The demi-centrum ovale is *the exciter of voice and speech;* and moreover the cerebral lobes are *the exciters of the intellectual faculties*. These excitations are the different instruments by which the mind displays its manifestations."

Frequent allusions being made, in the text, by M. Broussais, to the doctrines of Gall and Spurzheim, or the phrenological system, as they are now more generally called, it seems proper that we should place before the reader, an outline of this system, which comes so far in advance of any other, towards a knowledge of the separate faculties of the mind and their combined play and operation. We believe that our purpose will be answered by borrowing from our review, (in the twelfth volume of the North American Medical and Surgical Journal,) of Combe's work, entitled, "Observations on Mental Derangement, being an application of the principles of Phrenology to the elucidation of the causes, symptoms, nature, and treatment of Insanity."

That the brain is the material instrument of thought, the seat of intellect and sentiment, is, we believe, at this time, a familiar proposition; but it is not perhaps so generally known that it is rather a congeries of organs than a single organ, and that each of the congeries has its separate and peculiar function, which gives the faculty of the mind. The plurality of the mental faculties, their unequal power, their diversity in different individuals, were facts often alluded to and at times more explicitly admitted by moral philosophers. The history of genius could be no otherwise explained than by an admission of this nature. In it we see a strong predominant faculty eager and intent on the gratification and display of its powers, without reference to remote results of profit or honour—while at the same time this wonderful energy is often marked by a weakness of other faculties—a deficiency of those qualities of the mind largely participated in by other persons. Education exhibits farther confirmation of this principle, in the great difference

of attainments by persons possessing equal opportunities for learning—and in the unequal success, in the same individual, with which several mental faculties are cultivated—although equal appliances were made to all. Several young persons, for example, shall take lessons in music, and all be ambitious of success—and yet the advancement of one will be exceedingly rapid; of another very moderate, while a third makes no progress at all. Let drawing be the subject of study, and the facility of attainment may be the very reverse of that exhibited in the case of music. We meet with individuals remarkable for their power of verbal memory —ability to rehearse with very little trouble after a few readings of or hearing the longest discourse; but who are utterly unfitted to feel or appreciate its peculiar excellencies, or to reason on the philosophy or bearing of the topics advanced in it. Others again destitute of this faculty, or possessing it in a very limited degree, and deficient in all copiousness of elocution, will often astonish us by the depth and cogency of their reasoning, and the great felicity and variety of analogical illustration. We find a distinguished geometrician, without any poetical imagination or ability to carry out in ratiocinative series a problem in moral or ethical philosophy. The poet again is often an exceedingly indifferent observer of things and judge of mankind. Now these various marked differences of mental manifestations among men are not dependant upon accident, education, or both combined, in what is called the force of circumstances: they are the result of primary or innate aptitude for particular pursuits in preference to others. No possible combination of circumstances can create a faculty—they can at most only modify it.

If the intellects of men are thus various, the difference in their disposition is not less so. Nor are we less struck with the little correspondence between any purely intellectual faculty or combination of such faculties and a particular sentiment or disposition. Genius is allied to the greatest goodness in one man, and to a thousand crimes in another. We deduce from this and other similar facts the consequence, that the manifestations of disposition, in a feeling of benevolence, veneration, friendship, &c. or of cruelty, deceit, &c. are independent of those other modifications of mind constituting intellect. The greatest share of learning and attainments of the most varied and suprising kind, give no active impulse to deeds of charity and philanthropy. Devotion in a good cause, sacrifices for parents, home, country, religion, are the result of strong internal impulses, not of conviction by elaborate processes of reasoning and skilful logic. The mode of display may be affected by the intelligence of the person—but the strong, active impulse to a particular train of feeling and corresponding action is innate, strengthened but not given by the schools.

Seeing that the brain, in its totality, is the material instrument for the performance of the mental faculties in their totality, and that these latter are numerous and diversified in their nature, intensity of action and aptitude for cultivation, we naturally ask whether particular portions of the brain are not necessary for the manifestations of particular faculties. Having satisfied ourselves by observation of human nature, that there is a plurality of faculties of the mind, we should *à priori* infer plurality of organs, or portions, for specific functions of the brain. The same cerebral mass, supposing it for a moment a unit, could not be competent to perform opposite functions—an excitement of the former as a whole must be attended with augmented action of all the latter, and its repose be accompanied by a suspension of these. Thus if the faculty for music were to depend upon the entire brain, the manifestation of the former would necessarily involve the active

state of the latter. Of course all the other faculties possessed by the individual must be manifested at the moment of the musical effort with equal intensity, which we know is not the case. So far we might proceed in our reasonings and inductions by merely contemplating mental phenomena and the actions of men; but the direct material proof of the soundness of the doctrine would still be wanting. The general truth had been long felt and its importance acknowledged; but the world was without that specification of cerebral structure and minute observation of mental function, by which the direct palpable origin of the latter could be referred to the former.

The merit of original observation and direct legitimate induction in this branch of physiology belongs to the late Dr. Gall. When yet at school he was struck with the great differences in the capacities of his companions: he saw one at the head of his class, owing to his extremely tenacious memory; while he (Gall) was conscious that he better understood the subject of the lesson, but having a weaker memory could not with all his efforts appear to the same advantage in recitations as his companion. Being somewhat curious in the study of physiognomy, he set about observing the peculiarity of feature by which his rival of strong memory was distinguished. Gall found this youth to have unusually prominent eyes; and on looking around in the school and among his companions, he discovered that those who were remarkable for their facility in recitation, had also this same peculiarity. But when he afterwards had occasion to note, in the case of another of his companions, a strong and ready memory of places, but without this person having the full and prominent eye, he modified the inference which he had at first drawn regarding this character of eye as indicative of a retentive memory in general; he found that it was but of words in one's own or other languages, and did not by any means indicate a memory for places. The latter was evinced by a prominence at the lower part of the forehead just above the root of the nose. This discovery led him to see that mere physiognomy as commonly understood, that is, signs of intellect and disposition in the features of the face, could no longer guide him in his investigations. Other facts gradually taught him that the variations in external configuration corresponding with mental peculiarities, were of the skull and not of the bones of the face. Become a student of medicine and an anatomist, and made acquainted with the moulding of the skull on the brain and of the general functions of the latter, Gall now continued his observations with a view of detecting the correspondence between cerebral development and the activity of mental manifestation: "Being physician to a Lunatic Asylum in Vienna, he had opportunities, of which he availed himself, of making observations on the insane. He visited prisons and resorted to schools, he was introduced to the courts of princes, to colleges, and the seats of justice, and wherever he heard of an individual distinguished in any particular way, either by remarkable endowment or deficiency, he observed and studied the development of his head. In this manner by an almost imperceptible induction, he conceived himself warranted in believing, that particular mental powers are indicated by particular configurations of the head."* Gall began in 1796 to give courses of private lectures on the new science.

In 1800 Dr. Spurzheim commenced his labours along with Dr. Gall, and in that year assisted for the first time at one of the courses of lectures of the latter. While to Gall must be awarded the merit of originality, we cannot fail to admit

* Phrenological Transactions.—Edinburgh 1824.

that much of the philosophical character of the new system is due to the discriminative judgment of Spurzheim.

Without at this time entering into details which would lead us away from the main subject, it is sufficient to remark that the progress of physiological inquiry of late years has singularly confirmed the leading positions of the two German reformers. By comparative anatomy we learn that the difference in the brains of animals is correspondent with the difference in their instincts and propensities, and that the measure of the superiority of one class over another in regard to intelligence is found in the greater development of their brains upwards and forwards, that is, in the usual order of development from the medulla oblongata. By a comparison of idiots with intelligent persons, and by comparing these latter with each other, and observing the correspondence between particular aptitudes and dispositions, and size and configuration of the brain, as measured externally by the skull, physiologists are now generally agreed that in proportion to the fulness of the anterior part of cerebral convolutions will be the manifestation of intellect, while a large growth of the back part and behind the ears indicates the strength of certain propensities of a more animal nature. To these two grander features and divisions we may add a third, which consists in the fulness of the upper region of the brain under the sagittal suture and beneath the parietals, and which is associated with an endowment of sentiments of benevolence, veneration, hope, firmness of purpose, cautiousness of character, &c.*

"The phrenologists consider man by himself, and also compare him with other animals. When the lower animals manifest the same propensities and feelings as those displayed by man, the faculties which produce them are held to be common to both. A faculty is admitted as primitive: 1. Which exists in one kind of animal, and not in another; 2. Which varies in the two sexes of the same species; 3. Which is not proportionate to the other faculties of the same individual; 4. Which does not manifest itself simultaneously with the other faculties; that is, which appears and disappears earlier or later in life than other faculties; 5. Which may act singly; 6. Which is propagated in a distinct manner from parents to children; and, 7. Which may singly preserve its proper state of health or disease."

Carrying on their observations agreeably to these rules, phrenologists have arrived at the following conclusion:—The mental faculties are divided into two orders—of the *Feelings*, and the *Intellect*. The first are divided into two genera—1. *Propensities*. 2. *Sentiments*. The intellectual faculties are also divided into two genera—the *knowing*, and the *reflecting*. Each faculty has its material instrument or organ in the brain. The propensities do not form ideas; their sole function is to produce a feeling of a specific kind. These faculties are common to man and animals. They are—*Amativeness*, or propensity to physical love and sexual intercourse;—*philo-progenitiveness*, which produces the instinctive love of offspring in general;—*concentrativeness*, by which the mind maintains two or more powers in simultaneous or combined action, and determines the individual to fixedness of location and purpose;—*adhesiveness*, producing the instinctive tendency to attach one's self to surrounding objects, animate and inanimate—it disposes to friendship and society—it is stronger and the organ larger in women than in men;—*comba-*

* The reader, who is not conversant with the outlines of the Phrenological system, and of the location of the different organs, may soon obtain this kind of information by reference to the Elements of Phrenology, by George Combe, republished by E. Littell. It is illustrated with diagrams of the human head on which is marked the numbers of the organs. Mr. Baker, of this city, has also for sale the bust, or head in plaster, on which are more distinctly exhibited the various organs.

tiveness produces active courage, and when energetic, the propensity to attack,—*destructiveness* produces the impulse, attended with desire, to destroy in general; when energetic, it gives a keen and impatient tone to the mind, and adds activity and force to the whole character: anger and rage are manifestations of it;—*constructiveness*, in man, inspires with the tendency to construct in general, and the particular direction in which it is exerted depends on the other predominant faculties of the individual:—in the lower animals, it appears to be directed, in a great measure, to one special object, in the bird to a particular form of nest, in the beaver to the special fashion of a hut,—these animals being deficient in the generalizing and directing powers conferred on man;—*acquisitiveness*, a faculty which produces the tendency to acquire, and the desire to possess in general, without reference to the uses to which the objects, when attained, may be applied—the idea of property is founded on it; avarice is the result of its predominating energy;—*secretiveness*, produces the instinctive tendency to conceal the thoughts, desires, and emotions of the mind, and to suppress their manifestations, till the understanding shall have decided on their propriety and probable consequences,—it thus enables the individual possessing it to add slyness, cunning or prudence to other means of defence.

The *Sentiments*, or second genus of the *Feelings*, do not, any more than the propensities, form specific ideas—but are merely emotions of a certain kind, or tendencies to emotion. Several of them are common to man and the lower animals; others are peculiar to man. Those of the first variety are,—*self-esteem*, a name expressive of the nature of the faculty: its deficiency is attended with a want of confidence, and of a proper estimate of what is due to one's self: it is only when indulged in without restraint, and possessed in an inordinate degree, that it produces abuses, and displays itself in the shape of repulsive pride, wilfulness, arrogance, egotism; and makes up an ingredient in envy;—*love of approbation*, producing the love of the esteem of others, in praise or approbation—a due endowment of it is indispensable to an amiable character; it may degenerate into puerile vanity, and feigned professions of respect and friendship; the organ is generally larger in women than in men;—*cautiousness*, produces the emotion of fear in general, and prompts its possessor to take care—the tendency of it is to make the individual in whom it is strong, hesitate before he acts, and, from apprehending danger, to trace consequences, that he may be assured of his safety;—*benevolence*, produces the desire of the happiness of others, and disposes to compassion and active benevolence—it communicates mildness and cheerfulness to the temper, and disposes to compassion, and active desire to benefit our species, and to view charitably the actions and character of others.

Of the sentiments proper to man, we meet, first, with *veneration*, which produces the sentiment of respect and reverence, and, when directed to the Supreme Being, leads to adoration; it predisposes to religious feeling without determining the manner in which it ought to be directed, and contributes to our regard for antiquity, and our seniors;—*hope*, inspires with gay, fascinating, and delightful emotions, painting futurity fair and smiling as the regions of primeval bliss; it gilds and adorns every prospect with shades of enchanting excellence, while cautiousness hangs clouds and mists over distant objects, seen by the mind's eye;—*ideality* produces the feeling of exquisiteness and perfectibility, and delight in the 'beau ideal:' it is this faculty which inspires with exaggeration and enthusiasm, which prompts to embellishment and splendid conceptions. It is essential to the poet, orator, painter, and sculptor, and to all who cultivate the fine arts;—*wonder*, the sentiment of the marvellous, or *marvellousness*, a proneness to believe in myste-

rious incidents, tales of sorcery and witchcraft, &c.;—*conscientiousness*, a faculty which produces the feeling of obligation, incumbency, right and wrong—justice is the result of this sentiment, acting in combination with the intellectual powers; —*firmness* produces determination, constancy, and perseverance: fortitude as distinguished from active courage, results from it;—it gives perseverance in the exercise and manifestations of the other faculties;—in excess it causes obstinacy.

The first genus of the intellectual faculties, take cognizance of the existence and qualities of external objects, and form ideas: and correspond in some measure to the perceptive power of the metaphysicians. These faculties are *individuality*, or as more recently termed *eventuality*, which gives the desire, accompanied with the ability, to know facts and things, without determining the kind of knowledge, and without any view to the purposes for which it may be subservient. *Form*, aids the mineralogist, portrait painter, and all persons engaged in the imitative arts;—it gives the power of distinguishing faces. *Size*, gives an intuitive faculty in estimating the magnitudes of objects and of perceiving and judging of perspective. *Weight*, or *resistance*. *Colouring* gives a great natural power of perceiving colours, their shades, harmony, and discord; but the reflecting faculties adapt them to the purposes of painting. *Locality*, a faculty by which places once seen are well remembered and readily recognized; it conduces to the desire for travelling, and constitutes a chief element in the talent for topography, geography, astronomy, and landscape painting;—it gives what is called *coup d'œil*, and judgment of the capabilities of ground. *Order* gives method in arranging objects, as they are physically related; but philosophical or logical inferences, the conception of systematising, and the idea of classification, are formed by the reflecting faculties. *Time*—the special faculty seems to be the power of judging of time, and of intervals in general: by giving the perception of measured cadence, it appears to be the chief source of pleasure in dancing; it is essential to music and versification. *Number*, gives the conception of number and its relations—arithmetic, algebra, and logarithms belong to it. *Tune* gives the perception of melody; but this is only one ingredient in a genius for music. *Language* enables us to acquire a knowledge of, and gives us the power of using artificial signs or words: in ordinary conversation, the language of those having the organ large flows like a copious stream; in a speech, they pour out torrents. The second genus of the intellectual faculties or the reflecting ones, produce ideas of relation: they minister to the direction and gratification of all the other powers, and constitute what we call reason or reflection. First, *Comparison*, gives the power of perceiving resemblances, similitudes, and analogies; it explains one thing by comparing it with another, but does not discriminate the points on which they differ; and hence those in whom it is predominant, are, in general, more ready and plausible, than sound in their inferences. *Causality* furnishes the ideas of causation, as implying something more than mere juxta-position or sequence, and as forming an invisible bond of connexion between cause and effect: it gives deep penetration, and the perception of logical consequences in argument; the organ is large in persons who possess a natural genius for metaphysics, political economy; or similar sciences. *Wit*, is readily understood, yet difficult to define; it is a primitive faculty. *Imitation*, gives the power of imitation in general, as in mimicry, and when joined with secretiveness, it gives expression to the fine arts; it is indispensable to good actors, as well as to portrait painters, sculptors, and engravers.

The external surface of the skull corresponding with the anterior portion of the cranium, of which the organs giving the intellectual faculties consist, is of the

os frontis; of course the intellect has a much smaller proportion of brain than the sentiments and propensities, even in the most favourably organized subjects. In many it bears an exceedingly small proportion to the remainder, and we can in consequence readily conceive of their proneness to strong and exaggerated emotions, and wrong actions, running on even to insanity.

H. (Page 119.)

It is not our intention to make any comments on our author's section on Instinct; thinking as we do, that the principles proclaimed in it relatively to that subject, are, for the most part, substantially correct and sufficiently illustrated, and presented in a manner at once clear and forcible. Our only object in troubling our readers with this note, is to present a brief notice of the views entertained by some modern writers, in relation to the active agent, or instrument of the instinctive faculties; in other words, to that part of the nervous system, which presides over the acts of instinct.

M. Serres, M. Bellingeri, and other physiologists, believe that the fifth pair of nerves, one branch of which, as we have stated in a preceding note, is sensitive, while another imparts contractile power to the muscles which it supplies with twigs, appears to preside over the irreflected acts of animals. They remark, that in the vertebrata the development of instinct appears to be in a direct ratio with that of the fifth pair, and that the cephalic ganglia of articulated animals corresponding to those of the fifth pair, the instinctive properties are more developed in them than in the members of the other classes.

Mr. Parker, also considers, that the fifth pair is not only the bond of union between the two great families of animals, in their physical properties; but the uniting medium of their moral, intellectual or instinctive feelings, propensities and acts. He further remarks, that as the brain in the vertebral classes directs the operations of the mind, and the mind those of the body, so the fifth pair in the invertebral, presides over the wonderful and variable manifestation of instinct, and in the intermediate grades, becomes the connecting link between the two, as the brain is reduced and the fifth pair elevated in their organization and proportions to the general mass. "If we examine," Mr. Parker continues, "the central mass of the whole animal kingdom, we shall find the brain becoming more and more imperfect, as we descend from man to the guadrumana, from the latter to the cheiroptera, digitata, cetacea, reptiles and fishes; in the latter of which it is reduced to the simple elements composing the rudiments of this organ in the mammalia, reptiles, and birds.

"As the brain becomes more simple, and the intellectual faculties of which it is the seat, fewer and more imperceptible, the fifth pair and the instinctive faculties are more and more perfectly developed. In man these properties are purely rudimentary. He is governed by reason, but not enslaved by instinct. In him also the fifth pair, in comparison with the other parts of the nervous system is reduced to its minimum of existence. The simiæ, the dog, the elephant and most of the higher mammalia, though immeasurably below the human subject, appear to be directed by the impulse of brutish reason. In these animals also the fifth pair bears but an inconsiderable proportion to the general nervous mass; the instinctive faculties are indeed manifest, but not carried to the extent they are met with in many of the lower orders. In the seals and beavers, among the mammalia, these faculties are at their highest pitch of development, and seem rather to be the effect of an unerr-

ing reasoning power than the result of the organization of instinct. It is in these animals that the brain is reduced to a state of atrophy, whilst the fifth pair is carried to an enormous extent of development. This property, though brought to its highest perfection among the mammalia in the beaver, is nevertheless far inferior to the instinct of insects, as developed in the mechanical structure of the wasp, the bee and the spider. Here the brain is altogether wanting, the gasserian ganglion being the predominating part of the nervous system in all the invertebrata; and in the bee this organ is carried to its highest point of complexity and organization. This insect is placed, by the superiority of its instinctive faculties at the head of the invertebrata, because its cranial ganglia are the largest and most perfectly developed. Man holds the highest grade among the vertebrata, from the predominance of his brain over the other parts of his nervous system; in him instinct is null and the fifth pair rudimentary. These two organs, the brain and fifth pair of nerves, are always developed in an inverse ratio. The former goes progressively decreasing from man to the pisces, whilst in the invertebrata, it becomes the central and only system, and the predominating nervous influence.

"Through the whole animal series, we find the intellectual faculties becoming gradually more and more extinct as the brain loses its perfection of centricity, and is less and less perfectly organized. The instinctive faculties, on the contrary, are slowly carried to their highest point, as the fifth pair acquires an increase of size and development. These faculties and the fifth pair always bear towards each other the same relation; the effect is always proportionate to the cause. If the nerve is small, the faculty is rudimentary; if the former be more perfectly organized, the latter is met with in a greater degree of perfection."

I. (Page 136.)

The chapters on the intellectual and moral faculties, are the least satisfactory portion of this work. They are not free from a certain degree of obscurity, which renders it difficult, with many readers, to comprehend the meaning of the author; confusion often prevails in the ideas attempted to be communicated; and frequent inconsistencies and contradictions are to be detected.

M. Broussais has assumed in these chapters the character of an eclectic, which he has in other places so frequently denounced, and owes his want of clearness and precision to the attempt he has made to amalgamate doctrines that are irreconcilable.

A concise view of these doctrines will sustain this opinion, indicate the source of the errors, into which, we conceive, the author has fallen, and render the doctrines he has sustained more generally comprehensible.

The theories adopted for the explanation of the intellectual and moral faculties, may be reduced to two classes—the metaphysical and physiological. The first assumes the existence of a principle, unorganized, immaterial, self-existing, something divine, mysteriously connected with, but not depending on the body, and requires to be investigated distinctly from the animal organization. The second regards them in the light of functions, as the result of the actions of certain nervous organs, as proceeding from or immediately associated with organization, and, consequently, as entering into the history and study of the animal economy as a portion of it.

The first doctrine was sustained by the eloquence of Plato, who may be regard-

ed, from the extension it derived from the influence of his authority, as its founder. It was continued by Descartes, and was revived with modifications a few years past at Jena, by Kant, and is taught in Paris, at the present moment, by M. Cousin.

The second doctrine recognizes as its founder, the most profound and accurate of the ancient philosophers, Aristotle. It is that professed by the modern writers of highest authority—Bacon, Locke, Harvey, Condillac, Destutt-Tracy, Gall, Spurzheim, and Combe.

This last division embraces two different classes—the ideologists and the phrenologists. The first merely connecting the intellect with the brain, confine themselves to the investigation of the intellectual operations and the formation of ideas. The last press their inquiries farther, and attempt to develop the organization of the mind, to number its faculties, to arrange them in their order, to unite them to specific organs, and even to assign to those a positive location.

The ideologists differ from each other in many respects.—They do not agree as to the nature and number of the primitive faculties, or their development and operations. The work of Destutt-Tracy, (Elemens D'Ideologie) is probably the most clear, precise, and truly philosophical of this school.—Sensibility, he admits, as the only primitive faculty, of which memory, judgment and will, are merely modifications.

This doctrine of Destutt-Tracy has been adopted by Broussais, and he endeavours to incorporate it in his physiology and pathology. Thus he arrives at the conclusion, p. 120, that "*sensation, reflection and judgment*, are absolutely synonymous, and present to the physiologist nothing more than the same phenomenon;" and in the next paragraph he arrives at the same result with regard to the *will*. In these respects, Broussais is in perfect accordance with, and adopts implicitly the views of the ideologist. But in treating of sensibility, he departs entirely from the views of M. Tracy; he strikes it from the domain of physiology, becomes inconsistent with his own principles, and falls into ontology, which he so much deprecates in others.

M. Tracy, as a physiologist, considers sensibility "an effect of our organization," a power or attribute belonging to the brain and nervous system. Broussais, though he admits that thought—that the exercise of all the intellectual faculties, are dependant on the movements of the brain, adopts the inconsequent conclusion, that sensibility is "so astonishing, so difficult to conceive, that he regards it as immaterial." But, as he had previously announced, that sensibility and the intellectual faculties are the same phenomenon, the intellect must, then, be an immaterial principle, and in that case, ceasing to be a functional result of organs, it no longer belongs to physiology, in its present acceptation, for which he makes a strenuous reclamation. Once admit the immateriality of the sentient and thinking faculties, and it appears to us, that it is not possible to treat them, on physiological principles, or to oppose with success, the Platonic doctrine of innate ideas, in its primitive principles, or as modified by M. Cousin, whose doctrines have been combated by M. Broussais, in his work on Irritation and Insanity.

It is admitted by our author, that sensibility "is a forced state," and "cannot continue long:" that it is interrupted in its exercise by nature, and, "if prolonged beyond the limits she has imposed, it is a cause of disease." Sensibility differs from contractility (irritability, excitability.) This last is never interrupted—it is unceasingly in play. The first cannot, then, be a vital principle, but presents all the characters of a function; the last is a vital principle or property, without which vital phenomena are not manifested; it is the only vital principle; "sensibility is

one of the results of the play of this property." The preceding propositions, which are those of M. Broussais, are entirely hostile to his previous conclusion, that sensibility, and consequently the intellectual faculties, are immaterial. We do not intend to discuss the question of the materiality or immateriality of the mind; a discussion of very little utility—but it is necessary to be consistent; and if we adopt any other course, than that of a mere observation of the phenomena, such as we are able to observe and comprehend them, we must adhere to the evident result of our principles, to which ever side they may lead us.

M. Broussais admits the Aristotelian maxim adopted by all the ideologists.—*Nihil est in intellectu quod non priùs fuerit in sensu;* but, he adds, and very justly too, to the number of the senses, the mucous surfaces of the respiratory, digestive, urinary and genital organs. These are as much sensitive surfaces, as the skin, the nostrils, tongue, ear or eye, and, like them, receive and transmit impressions to the common organ of perception. They are the sources of ideas connected with the animal wants, instruct the intelligence in the condition of the organs, and are thus, the origin of the instincts, dictating by the prompt and often irresistible impulse of feeling, the acts necessary to individual conservation, and which would not be entrusted to the slow process of reason, guided by knowledge previously acquired through instruction or experience.

While M. Broussais has most correctly indicated the surfaces mentioned, as the seats of internal senses, and has enlarged on their importance in the study of the intellectual phenomena, he has, in his zeal, pushed beyond the goal, run a random course, and carried his speculations beyond the limit of rigid observation and implicit fact. That the internal and external senses are on the same line, in the production of ideas, may be conceded willingly by any one. Both receive impressions, the one from exterior agents, whence is derived a knowledge of their existence, and modes of existence—the other form the conditions, arising from internal or external causes, of the internal surfaces, which communicates a knowledge of those conditions, and often the relations between the internal surfaces and external agents. The one group of senses is for exterior, the other group, for interior purposes, and a superiority is not to be claimed with propriety for either. But M. Broussais does not regard them in this light. He assigns a most undue elevation and an extraordinary agency to the internal surfaces and senses in the production of ideas and even in sensations. In this respect, the physiological metaphysics of M. Broussais, are mere speculations, are hypotheses into which he has been led, from a wrong conception of the facts he has undertaken to solve.

According to our author, all external impressions are transmitted to a common centre—the medulla oblongata—thence they are irradiated through the whole nervous mass, and, if they bear a relation to any internal surface, it takes cognizance of the impression, reflects it back to the brain, and, then, perception takes place, sensation is experienced, and an idea is formed. If, however, the external impression finds no internal surface or sense which responds to it, and does not reflect it back to the brain, no perception exists, and no idea is created. This is a very complex proceeding, and founded, we believe, altogether on erroneous views, from inattention to two important phenomena of the intellectual operations, to which our author has never once adverted, as we shall presently show.

Had M. Broussais confined his hypothesis simply to those external impressions, and the ideas excited by them, connected with the instinctive wants, and necessary to their accomplishment, a plausible colouring could have been imparted to the whole fabric, but he has extended it so as to embrace the impressions of all external agents, and to explain the mechanism, if we may employ the term, of the

formation of all ideas, even the most abstract. The facts on which this hypothesis has been erected, are principally drawn from those connected with the instinctive wants, but admit of a very different solution from that adopted by M. Broussais.

To understand those facts, it is necessary to advert to two operations of the intelligence, which have been wholly overlooked by our author, and who, we are almost led to suspect, is not aware of their existence. These are, 1, active sensation, perception or attention; and, 2, association.

1. Two impressions are not perceived at the same instant. The mind may rapidly revert to one or the other; but a single perception alone engages the mind at any one time. If the mind be intently occupied with a perception or train of ideas, it is wholly or nearly unconscious of the impressions of surrounding objects, although they influence the sensitive surfaces; but, if the mind be directed towards any of those impressions, the perception of them is immediately vivid, and the corresponding ideas forcibly awakened. There are then, two conditions of our sensations. Active sensation—perception, or attention—which, in some systems, is regarded as a distinct faculty of the mind,—and passive sensation, in which impressions on the sensitive surfaces exist, but are neutralized by more powerful sensations, and are not perceived by intelligence.

2. By an operation of the intellect, a sensation, an idea, a sentiment, or a word, will, when present to the mind, immediately recall another sensation, idea, sentiment, or word, with which it had been on some former occasion united. The same occurrence will prevail indiscriminately, so that an idea will awaken a sentiment—or sensation; or a sensation recall an idea, or a word, or a propensity. In a similar manner, groups of sentiments, of propensities or faculties will be brought into action, the excitement of one producing an activity of another. To this operation of the intelligence is applied the term association.

Now, all the reasoning of M. Broussais on the effects of impressions, and the formation of ideas, is defective, from a total neglect of the important conclusions that have been pointed out. Inattention to these operations or conditions of the intellectual faculties, has caused a misconception of the phenomena on which his hypothesis is founded.—The examples quoted, "as the sight of the sky, the earth, a field, an edifice," are instances of the effects of association. It is admitted by our author, that the impressions made by those objects "very often do not appear to act on the viscera." But we are cautioned, not to infer on that account, that "those impressions are limited to the sense by which they are received, and to the brain to which this latter transmits them;" it is contended that they are much more extensive,—"Thus," it is asserted, "we may conceive in man the existence of a *state*, during which these impressions will act powerfully on the viscera; thus the aspect of the sky will excite emotions in an individual long deprived of it—the mariner after a tedious voyage will be rejoiced at the sight of land," —and so on with other analogous instances. Now, this *state* of which our author speaks, which appears to be wholly unknown to him, is association. A man long deprived of the aspect of the sky, when restored to it, has a thousand exciting sentiments, ideas, and even sensations, and sometimes passions, awakened by association. The love of liberty and freedom, so quickening in their influence, may be roused in his bosom—the delightful sensations he has experienced from exercise, from the movement of his limbs, from breathing the wholesome air, may be revived—his fancy may teem with the stirring ideas of friends, of connexions, of relatives, of all the enjoyments of social intercourse with his fellow-beings of which he has been deprived—these, and innumerable other sentiments and ideas,

may be awakened in an individual, under the assumed condition, by the aspect of the sky.

The mariner also, at the sight of land, associates with it the idea of his wife or mistress whose embrace awaits him, or he pictures to his fancy the warm greetings of his friends, or the numerous pleasures he anticipates to enjoy on his arrival.

These are instances, and strong ones, of association, when the impression of an object or an idea will call forth various sentiments, and ideas, and sensations.

The inference deduced from the preceding instances, by M. Broussais, that in the formation of all ideas, even abstract ideas, the viscera are equally participant with the brain, is clearly not justified by the premises. It is perfectly illogical to conclude, that because, under certain circumstances, an impression excites vivid emotions, often experienced in the viscera, and we have shown this to be accomplished by the principle of association, that, therefore, the primitive, simple idea excited by that impression, could not have been formed without the concurrence of the viscera. That is, the idea of the sky, derived from the sense of sight, could not, in the first instance, have been formed in the mind, without the impression made on the retina and transmitted to the cerebral organ of vision, having been previously irradiated into the whole nervous system, and found some viscus, the stomach, or bowels, to respond to that impression and reflect it back on the brain. This conclusion, we repeat, is quite illogical, and cannot be sustained by a clear investigation of the phenomena attending the formation of ideas.

Another fact, on which our author reposes with great confidence, and cites in more places than one, is entirely misunderstood by him, and he is in consequence led to conclusions not authorized by the facts. The example we allude to, is the one of a "man (who) sees another make water; if his bladder is empty, he feels nothing in that organ, if, on the contrary, it is full, he experiences a sensation which invites him to follow the example of the other." The explanation of this fact, by our author, is most singular, and exhibits a deficiency in the physiology of the sensations, that cannot but surprise us in a writer, who, in general, is so accurate an observer, and so just in his conclusions.

The explanation of our author is as follows:—The impression on the retina, of a man urinating, excites a "cerebral irritation," which is propagated into the nervous system. If the bladder be disturbed, it "feels an interest in the idea,"—it takes cognizance of the cerebral irritation—reacts on and "solicits the centre of perception by making it experience a sensation." Should the bladder, on the contrary, be empty, it "feels no interest in the idea, transmits nothing to the brain," consequently there is no sensation, no perception. In this hypothesis, the sensation in the bladder, and the perception of the want of urination, are made to depend on a primary impression on the retina. This most strange conclusion arises from inattention to the two important operations of the intellect which we have indicated, and which, we have said, are so entirely overlooked by M. Broussais, as almost to justify a belief that he is unacquainted with them.

There is no difficulty in explaining the phenomena on more consistent, direct, and simple principles. When the bladder is distended with urine, an impression is excited in its mucous tissue, or more probably in that lining its neck, analogous to an irritation from other causes; for an irritation of the neck of the bladder, uniformly causes the same sensation as that of a disturbed bladder. This impression on the bladder is experienced—probably is repeated in the brain to which it has been transmitted, and if the mind be unoccupied, that is, no other

stronger impression engages the mind, we become conscious of the existence of the local impression. It is this which constitutes perception and sensation. In the particular instance under consideration, we have the sensation of a want of urination,—should the brain be actively excited by this sensation, it becomes the predominant sensation—perception is then active, which is attention—that is, the intelligence is directed to the cognizance of the one sensation in preference to any other—and the gratification of the want is then the strongest motive influencing the will, or, in more positive language, the most powerful excitant of voluntary actions. But, let the mind be deeply employed in some other internal or external emotion—as in profound thought—abstract speculations—or some violent acute pain, the impression of the urine on the bladder, having a less intensity, does not excite active perception, attention to it is not awakened, the sensation is not experienced. In this state another may be seen to urinate, but should the occupation of the intellect be intense, the impression on the retina does not arrest and direct the train of thought, it is not in fact perceived, and the presence of the urine in the bladder will not be felt. Let the sight of another urinating, fix for a moment the attention, association immediately connects that idea with the act in ourselves, the impression of the distended bladder constantly transmitted to the brain, now excites instantly active perception, we are conscious of the local irritation, or experience the sensation of the want of urination, and the will is solicited to satisfy the want.

The other instances adduced by M. Broussais, as the supports of his hypothesis of the intellectual faculties and operations, are precisely analogous to the preceding, and are to be explained on the same principles. It is a strong evidence of the fallacy of these views of our author, that they have failed almost universally to make an impression; they can claim but few converts, and we believe have commanded no other advocate than their author.

The sources of the errors of M. Broussais, in his hypothesis of the intellectual faculties, we attribute to two causes:

1. The entire inattention to the important states of the intellectual faculties—constituting association, perception, and the production of sensations.

2. Having embraced the ideological system of M. Destutt-Tracy, and instead of following out his own principles, having attempted to reconcile and amalgamate that doctrine with his own.

That M. Broussais has failed in this attempt is not surprising. Between the two doctrines there is no point of contact—the means of union do not exist—and the effort to combine them has resulted in much speculation that is ingenious, without any positive or convincing demonstration.

In the physiological system, every phenomenon of the animal economy has assigned to it a positive valuation. It is always a fixed result—the product of an organ, and of appreciable and cognizable agents. The ideological system, on the contrary, is loose, general, and is engaged in determining the value of words, rather than the designation and appreciation of things.

The phrenological doctrine of Gall, illustrated by Spurzheim and Combe, is exactly on a line with the physiological doctrine of Broussais. The two run into each other, and, without the slightest discrepancy, form different parts of one system. It is alone on this doctrine, that the physiological and pathological principles of M. Broussais, can be made applicable to the intellectual phenomena in their physiological and pathological conditions, and this perfect adaptation of the two doctrines to each other, is no mean argument of the validity of both. This har-

mony, this unity of the phrenological doctrines with the Broussaisian principles, is finely displayed in the *Nouveaux Elemens D'Hygiene*, by M. Londe, one of the most intelligent disciples of the new medical doctrine.

K. (Page 230.)

The phrase in the text, that "the muscular apparatus and its appendages are put in relation with the brain and the various viscera by means of the vessels and nerves"—is not entirely accurate, and expresses confusedly, two distinct facts—1. The connexion between the muscles and the brain; and 2. The manner in which the former are nourished and kept in a state competent to the discharge of their functions. In the first, nerves alone are the connecting chain—in the second, both nerves and blood-vessels are required. As agents of volition, the muscles are brought into motion by a stimulus transmitted to them immediately and instantaneously from the brain by means of the nerves.—As organs requiring a constant supply of fibrin—their appropriate nutritive matter, they are under the dependence of the heart, from the left ventricle of which is transmitted to them by means of the aorta, and its branches, red blood. Cut off the connexion between the voluntary or cephalic muscles and the brain, and the phenomena indicated in the text take place. Deprive them of their customary supply of arterial blood, and like every other organ in the body they fall into a state of atrophy, and cease to respond to their specific stimulus.

It is not, we conceive, correct to speak, as the author has done, of the viscera any more than the brain, being put in relation with the muscular apparatus, by means of both nerves and blood-vessels. The relation established in this case is purely nervous—a stimulation or irritation excited in a viscus, becomes, or is immediately an action of the brain, and is transmitted from the latter to the muscles, rousing them to either accelerated voluntary movements, or violent involuntary convulsive ones, according to the extent of the visceral excitement or the disturbance. But all these phenomena have been linked together entirely by a nervous chain—they acknowledge no vascular one. For an inquiry into the precise modification of nervous structure, by which the brain governs the voluntary muscles, the reader is referred to the article, immediately following this.

L. (Page 240.)

The author, in this passing notice of the discovery of the two sets of nerves issuing from each side of the spinal marrow, having distinct functions, has awarded to his countrymen Magendie, the credit due to Mr. Charles Bell. As far at least as regards the initial idea and the experiments to determine its correctness, this latter gentleman may claim priority. As long ago as the year 1809 or 1810, Mr. Bell showed, that the posterior roots of the spinal nerves might be cut without impeding motion—the inference was natural enough, that as motion depended on nervous supply from the spinal marrow, it could only come from the anterior roots. The experimental proof of this fact, and thus of demonstrating the double offices of the roots of a spinal nerve, has been claimed, and as far as we know, rightfully for Magendie. Be this as it may, the collection of facts on this subject, as well as

of the respiratory nerves, into a connected and harmonized system, is the work of Mr. Bell, and to him we habitually refer as authority in these matters.

"In the view," says he, "which I have taken of the nerves of the human body, there are, besides the nerves of vision, smell and hearing, four systems combined into a whole. Nerves entirely different in function extend through the frame—those of sensation, those of voluntary motion, those of respiratory motion, and lastly, nerves, which, from their being deficient in the qualities that distinguish the three others, seem to unite the body into a whole, in the performance of the functions of nutrition, growth, and decay, and whatever is directly necessary to animal existence.

"These nerves are sometimes separate, sometimes bound together, but they do not, in any case, interfere with, or partake of, each other's influence."

"The key to the system will be found in the simple proposition, that each filament or track of nervous matter has its peculiar endowment, independently of the others which are bound up along with it; and that it continues to have the same endowment through its whole length."

"Different columns of nervous matter combine to form the spinal marrow. Each lateral portion of the spinal marrow consists of three tracks or columns, one for voluntary motion, one for sensation, and one for the act of respiration. So that the spinal marrow comprehends in all six rods, intimately bound together, but distinct in office; and the capital of this compound column is the *medulla oblongata.*

"These six columns of the spinal marrow are discoverable, on looking to the fore part of that body; but no doubt these grander columns contain within them subdivisions. Thus, if we lift up the medulla spinalis from the cerebellum, and look to it on the back part, we shall see numerous cords, the offices of which will one day be discovered."

This view of the constitution of the spinal marrow, led Mr. Bell to the discovery of the distinct functions performed by the several roots of the spinal nerves. He ascertained that

"The anterior column of each lateral division of the spinal marrow is for motion, the posterior column is for sensation, and the middle one is for respiration. The two former extend up into the brain, and are dispersed or lost in it; for their functions stand related to the sensorium; but the latter stops short in the medulla oblongata, being in function independent of reason, and capable of its office independent of the brain, or when separated from it.

"It is the introduction of the middle column of the three, viz.: that for respiration, which constitutes the spinal marrow, as distinct from the long central nerve of the animals without vertebræ, and which is attended with the necessity for that form of the trunk which admits of the respiratory motions.

"*Of the Nerves which arise from the Spinal Marrow—Comparison with the Nerves of the Encephalon.*

"The spinal nerves are perfectly regular in origin and distribution, and are thirty on each side. Each nerve has two distinct series of roots, coming out in packets or fasces; one from the posterior column, and one from the anterior column of the spinal marrow."

The posterior come out with remarkable abruptness from the column, and their funiculi, converging towards the foramen of the sheath of the spinal marrow, form a ganglion. The anterior are formed of funiculi or filaments, which come out with more irregularity than the former mentioned ones.

Contrasted with this symmetrical arrangement is the very great irregularity of the nerves called cerebral or intra cranial.

Mr. Bell wished to ascertain whether the phenomena exhibited, on injuring the separate roots of the spinal nerves, corresponded with what was suggested by anatomy. His predominant feelings of humanity made him hesitate to experiment on a living animal, and, therefore, rendering a rabbit insensible by a blow behind the ear, he exposed the spinal marrow. On irritating the posterior roots of the nerve, no consequent motion could be perceived in any part of the muscular frame, but on irritating the anterior roots of the nerve, at each touch of the forceps there was a corresponding motion of the muscles to which the nerve was distributed.

The next step of inquiry for our author, 'was distinctly indicated.' If he pursued the track of the anterior column of the spinal marrow up into the brain, would he find the nerves which arise from it to be muscular nerves.

In tracing the column upon the corpus pyramidale, he finds the origin of the ninth pair, which

"Has only one series of roots corresponding with the anterior roots of the spinal nerves, and that these roots come from the *tractus motorius*, and we cannot forget that this nerve is entirely devoted to the muscles of the tongue, that it is the motor of the tongue. Following up the corpus pyramidale, we find issuing from it the sixth nerve, a muscular nerve of the eye. Still following up the *tractus motorius* through the *pons varolii*, we come to the roots of the third nerve, the motor nerve of the eye. Thus all the nerves arising in one line, from the Crus Cerebri to the Cauda Equina, are muscular nerves."

"The next matter of inquiry was to ascertain how far the fifth nerve of the encephalon corresponded with the spinal nerves."

"Observing that there was a portion of the fifth nerve, which did not enter the ganglion of that nerve, and being assured of this fact by the concurring testimony of anatomists, I conceived that the fifth nerve was, in fact, the uppermost nerve of the spine, that is to say, the uppermost or most anterior of those nerves, which order the motion and bestow sensibility, in its extended sense, on the frame of the body."

The above details are derived from "An Exposition of the Natural System of the Nerves of the Human Body, by Charles Bell.—Published in London and Philadelphia.

The additional views and particulars obtained from Magendie and the European physiologists, are given with sufficient clearness in the following extracts from Spurzheim's Anatomy of the Brain, &c.

M. Magendie* found that sensibility was destroyed when the dorsal (posterior) roots of the spinal nerves were cut through, and that motion suffered when the abdominal (anterior) origins were the subjects of his experiments. He also observed that the abdominal side of the spinal cord was less sensible to pricking or cutting than the dorsal; but that the introduction of a probe along the axis of the part did not seem to have any influence either upon motion or sensation. The case of a man, who died in his sixty-sixth year at Charenton, seems to corroborate these ideas. During the last seven years of his life his organs of motion had been paralyzed, but those of sensation remained uninjured; his intellectual faculties were almost annihilated, and his excretions were all involuntary. Thus reduced, he died. On opening the body, the pyramidal and olivary bodies were found pulpy, and of a dirty gray colour. The same change was observed along nearly the whole of the anterior surface of the spinal cord, and penetrating through almost the whole thickness of the fibrous

* Journal de Physiologie Expérimentale et Pathologique, tom. iii.

bundles that compose it. The abdominal roots of the spinal nerves were still visible, but their consistence was much diminished. The dorsal surface of the cord, on the contrary, and its investing membranes, were in a healthy condition. I am, however, rather inclined to question the accuracy of the report in reference to the brain and cerebellum, when they are stated to have been in a natural state; for I observe that the skull was eburneous, and three times thicker than common. Such changes of the cranium are, I believe, constantly accompanied by alterations in the encephalic masses.

M. Magendie also mentions a singular case, observed by M. Rullier, of a man who died at the age of forty-four. Up to his last hour this person possessed great moral energies, strong generative powers, free motion of his lower limbs, and perfect sensation in his upper extremities. The arms, however, were rigid, their muscles being permanently contracted, and often painful. They were rotated inwards, and pressed to the sides of the body, from which they could not be separated, but with some considerable effort. The fore-arms were in a state of uneasy pronation, the hands flexed, and all the fingers bent. On dissecting the body after death, "the spinal cord, examined with care, appeared in its natural state, from its upper end as low down as the exit of the fourth pair of cervical nerves. The dorsal surface of its two lower thirds was also healthy, but between the portions named, and through a space corresponding to the branching of eight or nine pairs of nerves, (six or seven inches in extent,) there was a very decided alteration. The spinal cord was there so extremely soft and diffluent, that the sheath formed by the dura mater seemed filled with a true fluid, which, indeed, flowed upwards or downwards, as the body was inclined. A puncture being made through the sheath, a considerable quantity of fluid instantly escaped."

"M. Boulay, jun. veterinary surgeon at Paris, relates the case of a horse, whose hind legs were completely paralyzed, whilst their sensibility was extreme. On opening his body, the whole of the lower part of the spinal cord was found soft and diffluent. There were no traces of change in the superior portion. The nervous substance of the lumbar and sacral pairs of nerves was but little consistent, and their sheaths were red and inflamed.

"The distinction of the nervous roots into dorsal and abdominal, accords with the two sorts of function performed by the spinal mass. This subject, however, still requires elucidation; for M. Magendie remarks, that "when the posterior roots, covered even with their sheaths, are irritated, signs of extreme suffering are manifested; and, what is particularly deserving of notice, contractions of those muscles that receive nerves from below the place so irritated are excited; these contractions, too, only occur on the side of the body the nervous fibres of which are pricked." According to the observations of the same author, the abdominal surface of the spinal cord is not altogether insensible when irritated. The communication between the spinal cord and the nerves of the vegetative functions is also known to be established by means of fibres, which communicate directly with the abdominal roots of the spinal nerves; nevertheless, the will has no influence over the functions of the viscera. Moreover, the fibres of the dorsal roots are evidently larger than those of the abdominal; both are in proportion to the volume of the parts to which they are distributed, and both send off branches that run into muscles. It is improbable, therefore, that the dorsal roots are solely destined to general sensation. Neither does it seem to me at all likely, that the spinal cord and its nerves are mere conductors of sensation, and of volition in reference to motion. I rather conceive that they aid in maintaining the powers of those parts to which they are

distributed; for instance, that the muscles, or instruments of motion, acquire their power, in part, through the influence of their nerves, whilst the will to make the muscles act resides in the brain. Thus I do not believe that the only office of the spinal cord, with its nervous roots, is to establish a communication between external impressions and the brain, and between the brain and the instruments of motion—the muscles. To me it seems probable, that a very small part of the spinal cord suffices for these purposes; the particular portion, or organ, however, cannot, in the present state of our knowledge, be specified. The experiments of M. Magendie prove the abdominal roots to include the conductors of volition; but as each of these is composed of two halves, the one superior, the other inferior, and, in man, of two distinct cords, it would be interesting to repeat and to extend the experiments, and by cutting the halves separately, to ascertain whether both propagate the dictates of the will; or if this task is limited to one, to that, namely, which does not communicate with the intercostal nerves. The ganglions of the intercostal nerves, as well as those of the dorsal roots of the spinal cord, may possibly prevent the will influencing the functions of the parts, to which these nerves are distributed.

"The set of experiments instituted by Dr. Bellingeri, and detailed in a Memoir read before the Royal Academy of Sciences at Turin, in February, 1824, do not tend to throw any new light on this interesting subject. They confirm the general idea upon the presence of separate nerves of sensation and of motion in the spinal cord; but they, farther, accord motion to the nerves that issue from the dorsal roots. Dr. Bellingeri says, his experiments prove, 1st, that the *posterior* roots of the lumbar and sacral nerves produce the motion of extension in the lower extremities; 2d, that the posterior roots alone preside over sensation; 3d, that the anterior roots produce the motions of flexion in the sacral extremities, and do not aid in perceiving external impressions; 4th, that the posterior bundles of the spinal cord preside over the motions of extension of the inferior extremities, and have no connexion with perceptions of touch; 5th, the white substance of the spinal cord, and the nervous fibres that arise from it, are appropriated to motion; and, 6thly, that the gray substance of the cord and the nervous fibres that spring from it, belong to sensation."

"I do not think," says Spurzheim, "with Dr. Bellingeri, that the vertebral nerves can be divided into those which come from the white, and those which issue from the gray, substance of the spinal cord; because, on examining the structure of this part and its nerves, I find that the origins of the latter invariably present the same appearance; they are universally implanted, as it were, into the gray substance of the cord."

Mr. Bell, who as may be readily presumed, feels too deeply interested in the question to allow the objections that may be urged against the system, of which he is the principal defender, if not the founder, to remain unanswered, has offered an ingenious explanation of the two sets of nerves in the muscles. According to this distinguished physiologist, the muscles receive through the motor nerves the cerebral influx which excites them to contraction; while the sensitive nerves convey to the brain a sensation, by which the sensorium is apprized, whether the commands of volition have or have not been executed by the muscles. Without the influx of nervous power, conveyed by the first set of nerves to the muscles, they would not contract, while, on the other hand, were it not for the transmission to the brain of a sensation through the agency of the sensitive nerves, the

brain could not ascertain whether the muscles were actually in a state of action, remained inactive, or had already ceased to act.

It follows from this, that the muscles are united with the brain by a complete nervous circle; one half of which consists of the agents for the transmission of contractile excitement; and the other half of those agents, which convey to the sensorium the sensation of the modifications experienced by the muscular apparatus. It is through the instrumentality of the last set of nerves, that the sensorial organ perceives the state of fatigue experienced by the muscles, as well as that of pain caused by the irritation, inflammation, and other morbid states of these parts.

The following extracts from Mr. Bell's late volume on the nerves will be read with interest, as they convey his views on the subject before us:

"The muscles have no direct connexion with each other, they are combined by the nerves, but these nerves, instead of passing betwixt the muscles, interchange their fibres before their distribution to them, and by this means may combine the muscles into classes. The question, therefore, may thus be stated; why are nerves, whose office it is to convey sensation, profusely given to muscles in addition to those motor nerves which are given to excite their motions? and why do both classes of muscular nerves form plexuses?

To solve this question, we must determine whether muscles have any other purpose to serve than merely to contract under the impulse of the motor nerves. For if they have a reflective influence, and if their condition is to be felt or perceived, it will presently appear, that the motor nerves are not suitable internuncii between them and the sensorium. *I shall first inquire, if it be necessary to the governance of the muscular frame, that there be a consciousness of the state or degree of action of the muscles.* That we have a sense of the condition of the muscles appears from this: that we feel the effects of over exertion and weariness, and are excruciated by spasms, and feel the irksomeness of continued position. We possess a power of weighing in the hand:—what is this but estimating the muscular force? We are sensible of the most minute changes of muscular exertion, by which we know the position of the body and limbs, when there is no other means of knowledge open to us. If a rope-dancer measures his steps by the eye, yet on the other hand a blind man can balance his body. In standing, walking and running, every effort of the voluntary power, which gives motion to the body, is directed by a sense of the condition of the muscles, and without this sense we could not regulate their actions.

"If it be granted, that there must be a sense of the condition of the muscles, we have next to show that a motor nerve is not a conductor towards the brain, and that it cannot perform the office of a sensitive nerve." Mr. Bell's arguments and facts, in support of the existence of the two sets of nerves, having already been stated, we shall merely offer the following quotation, in reference to the question before us: "Indeed reason uniting with experience, would lead us to conclude, that whatever may be the state, or the nature of the activity of a motor nerve during exertion, it supposes an energy proceeding *from* the brain *towards* the muscles, and precludes the activity of the same nerve in an opposite direction at the same moment. It does not seem possible, therefore, that a motor nerve can be the means of communicating the condition of the muscles to the brain." "Now it appears the muscle has a nerve in addition to the motor nerve, which being necessary to its perfect function, equally deserves the name of muscular. This nerve, however, has no direct power over the muscle,

but circuitously through the brain, and by exciting sensation it may become a cause of action." "If the circle be broken, by the division of the motor nerve, motion ceases; if it be broken by the division of the other nerve, there is no longer a sense of the condition of the muscle, and therefore no regulation of its activity." "We have seen that the returning muscular nerves are associated with the nerves of sensibility to the skin, but they are probably very distinct in their endowments, since there is a great difference between conveying the sense of external impressions, and that of muscular action.

"In surgical operations, this fact is forced upon our attention, that the pain of cutting the skin is exquisite, compared with that of cutting the muscles; but we must remember, that the pain is a modification of the nerve, serving as a guard to the surface, and to the deeper parts consequently. This is further exemplified in the sensibility of the skin to heat; whilst, on the contrary, a muscle touched with a hot or cold sponge during an operation, gives no token of the change of temperature but by the degree of pain. Many of the nerves, which perform the most delicate operations in the economy, are not more sensible to pain than the common texture of the frame. The lower degree of sensibility to pain possessed by the muscles, and their insensibility to heat, is no argument against their having nerves, which are alive to the most minute changes of action in their fibres."

There is a circumstance connected with the subject of the nerves distributed to the muscles, which deserves attention in this place. We allude to the fact, that organs which co-operate in the performance of several functions, and receive their motor nerves from several roots, may be paralyzed in a portion of their action and remain unimpaired as regards the other functions they have to perform. Thus the muscles of the face, neck, and shoulders, which are subservient to respiration, sometimes lose the power of executing voluntary movements, while they, nevertheless, continue to contract, even with energy, in order to effect the movements required for the act of inspiration.

M. (Page 280.)

This would seem to be the place for introducing a notice of the nerves termed irregular or respiratory by Mr. Bell—irregular, because coming out from each side of the lateral part of the medulla spinalis and oblongata, and by single roots and at unequal intervals—and respiratory, on account of their distribution to the lungs, and to the muscles, as well those of the openings of the respiratory passages as those proper to the thorax, and others common to this latter and the upper extremities.

Mr. Bell thinks, that the relationship between the nervous mass called medulla spinalis and the vertebræ, forming the spine, is not simply owing to the protection afforded by the latter, but consists likewise in the necessary continuation of the thorax into the spine, for the motion of respiration, and the necessity of the spinal marrow to that form of distribution of the nervous system, which is required for associating and combining the muscles of respiration. It will be remembered that we have already, in the article preceding this, stated, after Mr. Bell, that each lateral portion, or half of the spinal marrow regarding it longitudinally, consists of three tracks or columns, one the anterior or abdominal, for voluntary motion, one the posterior or dorsal, for sensation, and one central, for the act of

respiration. The extent of this last is, however, limited, for while the other two columns extend all the way from the point of origin of the fifth pair down to the cauda equina, it is restricted to the small region between the origin of the fourth pair to the oblique muscles of the eye and that of the inferior external respiratory distributed to the serratus magnus.

The nerves in question are described by Mr. Bell as "distinguished by a single fasciculus, or single root; that is, a root from one column. These are *simple* in their origin, *irregular* in their distribution, and deficient in that symmetry which characterizes the first class. They are superadded to the original class, and correspond to the number and complication of the superadded organs. Of these, there are the third, fourth, and sixth, to the eye; the seventh to the face; the ninth to the tongue; the *Glosso-Pharyngeal* to the pharynx; the *Nervus Vagus* to the larynx, heart, lungs, and stomach; the *Phrenic* to the diaphragm; the *Spinal Accessory* to the muscles of the shoulder; the *External Respiratory* to the outside of the chest."

These nerves, Mr. Bell conceives to be agents of distinct powers, and to combine the muscles in subserviency to different functions.

He very properly, we think, in his first paper to the Royal Society, considers as contributing to respiration, the muscles of the face, neck, and shoulders, as well as those of the thorax and abdomen,—all which are alternately or conjointly called into play, in the common actions of coughing, sneezing, speaking, and singing.

The nerves of the face, are, first, the *trigeminus*, or the fifth pair, and that familiarly called the *portio dura* of the seventh; "but which, in this paper, will be called *the respiratory nerve of the face*."

The fifth is the nerve of taste, and of the salivary glands, of the muscles of the jaw, and of common sensibility.

The portio dura, or respiratory nerve of the face, rising from the *medulla oblongata*, close to the *nodus cerebri*, and exactly where the *crus cerebelli* joins the *medulla oblongata*, passes into the internal auditory foramen, and is here embraced by the *portio mollis;* from which, however, it separates, and is received into an appropriate canal of the temporal bone. This nerve has, by means of the Vidian nerve and *chorda tympani*, access to the muscles of the back of the palate and the *velum palati:* emerging through the stylo-mastoid foramen, it divides into many branches,—one going to the muscles of the outward ear, another to the muscles of the throat. The principal nerve then passes through the parotid gland, and comes upon the face—spreading upwards to the temple, and downwards upon the side of the neck, forming a superficial plexus. The chief branches, however, go forward to the muscles of the forehead and eyelids; a branch called the superior facial is sent to the muscles of the cheek, and side of the mouth; while an inferior facial branch is given to the angle of the mouth, and the muscles which concentrate there.

By experiments on animals, it was conclusively ascertained, that a section of the branches of the fifth pair was followed by a loss of feeling in the part, without motion being impaired; while a section of the portio dura was attended by a loss of motion in the muscles of the face, including those of the mouth and nose, without sensation being injured.

"On cutting the respiratory nerve on one side of the face of a monkey, the very peculiar activity of his features on that side ceased altogether. The timid motions of his eyelids and eyebrows were lost, and he could not wink on that side; and his

lips were drawn to the other side, like a paralytic drunkard, whenever he showed his teeth in rage."

Corroborative facts to this end are met with in the human face, when the trunk of the respiratory nerve has been injured by wounds, or tumours of the parotid gland. The inference to the surgeon, in performing operations on the face, is highly important. Nor can the physician fail to be aided in his diagnosis of paralysis, and determining whether it proceeds from the brain, or is a partial affection of the muscles of the face, " when, from a less alarming cause, they have lost the controlling influence of the respiratory nerve."

Our author gives cases of disease, in which this nerve had suffered, and which had been attended with the above enumerated symptoms.

"Thus it appears, that the portio dura of the seventh nerve is the principal muscular nerve of the face; that it supplies the muscles of the cheek, the lips, the nostrils, and the eyelids; that is, that it is the nerve which orders all those actions which are in the remotest connexion with the act of respiration."

In his next paper, in the work* already quoted from, the author gives an account of the nerves which influence the motions of the trunk of the body, in respiration.

The offices of the thorax are first given; then the origin of the respiratory nerves; and the muscles of the trunk, which are brought in aid of the common respiratory muscles. These are the mastoid muscle, the trapezius, the serratus magnus, and the diaphragm. "The nerves which give rise to the extraordinary intricacy of this system on the side of the neck, are the spinal accessory nerve, the phrenic nerve, and the external thoracic nerve." The second of these, or spinal accessory, is called the superior respiratory nerve of the trunk, and is distributed, after giving off some minor branches to the mastoid and trapezius muscles. Even in complete hemiplegia, these muscles will act in respiration, in virtue of the respiratory nerve distributed to them.

The thorax, besides affording protection to the heart and lungs, and the viscera of the higher region of the abdomen, performs the following offices:

"1. It alternately opposes and yields to the weight of the atmosphere, thus producing respiration.

"2. In addition to the uniform motion of the chest in breathing, there is the occasional increase and agitation commensurate to the excited state of the animal frame, when additional muscles are brought into action.

"3. There is the exertion of the respiratory apparatus in natural voice, and in articulate language.

"4. Through the nerves and muscles employed in respiration are also exhibited the emotions and passions of the mind.

"5. The organs of the sense of smelling, and particularly the muscles which move the cartilages of the nose, are, in their exercise, as necessarily joined to the act of inspiration, as those of speech are to the act of expiration.

"6. The acts of coughing, sneezing, vomiting, and yawning, belong to this system of parts.

"7. The powers of the arms in voluntary exertion are in a great measure dependent upon the expansion of the thorax; so that the act of inspiration is always combined with sudden and powerful exertion. The more, indeed, we attend to the motions of the frame, whether in efforts of strength, or in the act of respira-

* An Exposition, &c.

tion, the more remarkable will the unexpected combinations of the muscles appear.

"It is only when we are made sensible of the extent of the respiratory actions, and that they, in effect, extend over the whole face, and neck, and trunk, that we can comprehend how the mechanism of the thorax, or rather of the respiratory apparatus generally, affects the arrangement of the whole nervous system. Whenever, in examining the comparative anatomy of animals, we find ribs rising and falling by respiratory muscles, we have a *medulla spinalis*, and the distinction of *cerebrum* and *cerebellum*. And experiment and observation prove, that the seat of that power which controls the extended act of respiration is in the lateral portions of the *medulla oblongata*, from which it is continued through certain respiratory nerves which pass out from the neck, and also downwards, by corresponding columns of the spinal marrow, to the intercostal nerves."

Under the head of *Comparative View of the Respiratory Nerves*, Mr. Bell makes the following observations, which we give entire.

"If we examine the *par vagum*, the *portio dura* of the face, the *external thoracic*, the *diaphragmatic*, the *spinal accessory* nerves, by comparative anatomy, we shall conclude that they are all respiratory nerves, by their accommodating themselves to the form and play of the organs of respiration. In fishes, the respiratory nerve* goes out from the back part of the *medulla oblongata*. When it escapes from the skull it becomes remarkably enlarged, and then disperses its branches to the branchiæ and the stomach. But from the same nerve go off branches to the muscles moving the gills and operculum, whilst a division of the nerve is prolonged under the lateral line of the body to the tail. It is said, this division sends off no branches, but this is not correct; it gives branches in regular succession to the muscles from the shoulder to the tail. Experiments have been made upon these nerves, but their detail would lead us too far. It is scarcely necessary to add, that there are neither phrenic nor spinal accessory, nor external thoracic nerves in fishes, the order of their muscular system not requiring them. In birds, the structure of the wing, and the absence of the mastoid muscles, render the spinal accessory nerve unnecessary; it is wanting, for the reason, that in the absence of the diaphragm there is no phrenic nerve. Quadrupeds have the three respiratory nerves of the trunk; but even in them there are variations in the muscular frame, which illustrate the appropriation of the nerves. The construction of the neck of the camel is like that of birds; there is a succession of short muscles along the side of the neck, and attached to the vertebræ; but there is no long muscle, like the *sterno-cleido-mastoideus*, contributing to the motion of respiration. There is, accordingly, no spinal accessory nerve in the neck of this animal.

We have a remarkable example of the manner in which these nerves vary in their course of distribution, and yet retain their appropriate functions, in the nerves of the neck of birds. In them, the bill precludes the necessity of the portio dura going forward to the nostrils and lips; the nerve turns backwards, and is given to the neck and throat; and it is particularly worthy of remark, that the action of raising the feathers of the neck, as when the game cock is facing his opponent, is taken away by the division of this nerve. If we compare the anatomy of the facial respiratory nerve, in the various classes of birds, we shall find its distribution to be analogous to that of the same nerve in the different tribes of quad-

* The nerve which by its subdivision supplies the heart, lungs, and stomach, and the muscles of the gills.

rupeds. In the game cock, a few branches of the nerve pass to the loose skin under the jaw, which is dilated in crowing, the greater number being distributed on the muscles of the neck, which causes the elevation of the feathers when he puts himself in an attitude for fighting. But in the duck, which, when enraged, has little or no power of expression, the same nerve is not larger than a cambric thread, and passes only to the skin under the jaw.*

In further illustration of the functions of these nerves, the author continues:

"Before having recourse to experiments on brutes, we may observe what takes place in our own bodies. By placing the hand upon the neck, we may be sensible that the mastoid muscle has two motions. The lower extremity of the muscle is fixed when we move the head; but when we use the muscle in inspiration, the head, and consequently the upper extremity of the muscle, are fixed. Now, if we endeavour to raise the sternum through the operation of this muscle, we shall find that other muscles are, insensibly to us, brought into action, which have nothing to do with this raising of the sternum. For example, if we strain to raise the lower extremity of the muscles, we shall unavoidably produce an action of the muscles of the nostrils; by which association of actions, we shall discover, that we are using the *mastoideus* as a respiratory muscle. If we reverse the action, and move the upper extremity of the muscle, other muscles will be drawn into co-operation, but they will be such as assist in the motion given to the head. Or we may vary the operation in another way. In snuffing or smelling, if we place the fingers on the portion of the mastoid muscles which are attached to the sternum, we shall find every little motion of the nostrils accompanied with corresponding actions of the sternal portions of the muscles in the neck.

"When a man suffers fracture of the spine at the sixth cervical vertebræ, and the marrow is crushed, he continues to breathe by the influence of the three nerves which arise above the injured portion. He inspires with force; but he cannot perform expiration by muscular effort, it is only by the elasticity and gravitation of the parts. He can yawn, for that is an action of drawing the breath; but he cannot sneeze, for that is an action of expelling the breath. But this is a subject so curious in itself, and which has hitherto been considered so carelessly, that I shall reserve it for a distinct dissertation.†

"A man having a complete hemiplegia, the side of his face relaxed, the arm hanging down powerless, and the leg dragged in walking, we were curious to know if the influence pervaded all the nerves of the side, or only the regular or voluntary nerves. Some trouble was taken to make him heave up the shoulder of the debilitated side, but to no purpose. He could only do it by bending the spine to the other side, and as it were weighing up the paralytic shoulder. But on setting him fairly in front, and asking him to make a full inspiration, both shoulders were elevated at the same time that both the nostrils were in motion. The respiratory nerve of the face, and the superior respiratory nerve, were entire in their office; and, although the regular system of nerves refused acting, the *sterno-mastoideus*

* These respiratory nerves of the thorax, the diaphragmatic, the superior, and the external thoracic nerve, are all nerves of *inspiration*. The act of inspiration is provided for in a more especial manner than the act of expiration. It requires more muscular effort, and is more essential to life. Inspiration is the first act of resuscitated life, the last of exhausted nature, and for this reason the muscles of inspiration are large and powerful, and the nerves in a double order; for not only do the lateral branches of the spinal marrow influence the act of inspiration, but these additional respiratory nerves descend from the upper part of the spinal marrow to the chest, as an additional and especial provision, guarding life.

† See the observations, p. 96.

and the *trapezius* partook of their share in the act of respiration. Seeing that the mastoid muscle has two sets of nerves, that one of these is of the class of voluntary nerves, and the other of respiratory nerves, are we not borne out in concluding, that when the head is moved, being a voluntary act strictly, it is performed through the common class of voluntary nerves? that when the chest is raised, is an act of respiration, and is effected through those nerves which control the muscles in respiration?

"This conclusion is confirmed by the following experiment. In the ass, there are two muscles which take the office of the mastoid muscle; one is inserted into the jaw, which we may call *sterno-maxillaris,* and the other into the vertebræ, viz. *sterno-vertebralis.* To these the superior respiratory nerve (or spinal accessory) is distributed in its passage to the trapezius. These muscles are at the same time supplied with numerous nerves directly from the spinal marrow. If we expose the superior respiratory nerve, and then induce excited respiration, so as to bring these muscles into powerful action in combination with the other muscles of respiration, and if, while this action is performed, we divide the nerve, the motion ceases, and the muscle remains relaxed until the animal bring it into action as a voluntary muscle.

"An ass being thrown, its phrenic nerves were divided, on which a remarkable heaving of the chest took place. It rose higher, and the margins of the chest were more expanded at each inspiration. There was no particular excitement of the muscles of the neck, shoulder, or throat, at this time; so that to excite the actions of these muscles it was necessary to compress the nostrils. When they began to act with more violence, keeping time with the actions of the other muscles of respiration, the superior respiratory nerve was divided; immediately the action ceased in the muscles attached to the sternum of the side where the nerve was divided, while the corresponding muscles of the other side continued their actions.

"After dividing the spinal marrow between the vertebræ of the neck and those of the back, respiration is continued by the diaphragm: which experiment, as it is often mentioned by physiologists, the author has not thought it necessary to repeat, but only to institute the following experiment on an ass. The phrenic nerve being first divided, and then the spinal marrow cut across at the bottom of the cervical vertebræ, respiration was stopped in the chest; but there continued a catching and strong action at regular intervals in the muscles of the nostrils, face, and side of the neck. The main part of the apparatus of respiration was stopped, but these accessory muscles remained animated, and making ineffectual endeavours to perform the respiration. When apparent death had taken place, the ass was reanimated by artificial breathing, and then these muscles on the face and neck were restored to activity, and became subject to regular and successive contractions, as in excited respiration, whilst the chest remained at rest. These actions continued for a short time, and then ceased; but upon artificial respiration being again produced, the same results followed. This was repeated several times, the animal remaining insensible during these experiments.

Upon stimulating the nerves after the death of this animal, it was observed, that the class of respiratory nerves retained their power of exciting their respective muscles into action, long after the other nerves had ceased to exert any power; they were evidently of that class which retain their life the longest.

"It is a duty to avoid the unnecessary repetition of experiments, and I have now to make a short statement of facts, resting on the highest authorities: experiments made without reference to the views now presented to the Society.

"The division of the recurrent branch of the *par vagum* destroys the voice.*

"The division of the laryngeal branch of the *par vagum* stops the consent of motion between the muscles of the *glottis* and the muscles of the chest.†

"The injury or compression of the *par vagum* produces difficulty of breathing.‡

"By the assistance of these well-known facts, we complete the knowledge of the circle of actions which result from the respiratory nerves.

"The *medulla oblongata* and *spinalis* are composed of columns of nervous matter, and from the different powers of the nerves, as they arise from the one or other of these columns, it is proved that they possess distinct properties. In animals that breathe by ribs and a numerous class of muscles, and which animals have a spinal marrow, we see that a column of nervous matter is embraced between the anterior and posterior *virgæ* of that body, and that this portion may be traced downwards between the roots of the spinal nerves. From the upper part of this column, where it begins in the *medulla oblongata*, the several nerves proceed which have formed the subject of these papers, and on the influence of which, it has been proved, the motions of respiration principally depend. It is not an extravagant conclusion to say farther, that the power of the regular succession of intercostal and lumbar nerves, as far as they regulate the respiratory actions, proceeds from the connexions of the roots of these nerves with this column, which is continued downwards, and which can throughout be distinguished from the rest of the spinal marrow.

"We are now enabled to distinguish the influence of the spinal marrow, and its regular succession of nerves, from those which have been traced in these papers. The first are essential to the act of respiration; without them the others are unequal to the task. But on the other hand, although the regular succession of spinal nerves be equal to the raising and depressing the thorax, they are not equal to the full heaving of the chest in animated exertion of the voice. They are not competent to the performance of the motions of the glottis, pharynx, lips, and nostrils, which several parts are necessarily influenced in excited respiration, as well as in the acts of smelling, coughing, sneezing, and speaking: for these, the co-operation of the whole extended class of respiratory nerves is required.

"Surveying the complicated machinery which in man is prepared for these various offices, we may reap the benefit of these fatiguing details, in the contemplation of the most interesting phenomena in nature. The relations of the subject may be presented under the heads of pathology, and expression.

Connected with the phenomena of respiration, are certain movements of the eye-ball, which have their origin in the various states of the fourth pair of nerves, or the pathetic. On this subject Mr. Bell undertakes to show that—

"We must distinguish the motions of the eye according to their objects or uses, whether for the direct purpose of vision, or for the preservation of the organ; that the eye undergoes a revolving motion not hitherto noticed; that it is subject to a state of rest and activity; and that the different conditions of the retina are accompanied by appropriate conditions of the surrounding muscles; that these muscles are distinguished into two natural classes; and that in sleep, faintness, and insensibility, the eye-ball is given up to the one, and in watchfulness, and the full exer-

* Sectis ambobus nervis recurrentibus vox perit: *Arnemann, Somerring, Morgagni.*

† *Le Gallois.*

‡ Vinculo compressis nervis vagis oriuntur in bestiis spirandi difficultas, surditas, vomitus, corruptio ciborum in ventriculo. *Sommering, Haller, Brun de ligaturis nervorum.*

cise of the organ, it is given up to the influence of the other class of muscles: and, finally, that the consideration of these natural conditions of the eye, explains its changes, as symptomatic of disease, or as expressive of passion."

To the question which might be very naturally asked, why should the small branch of the portio dura distributed to the eyelids be called a respiratory one, the author replies in the following terms:

"The name was given to excite attention to certain relations; that the question might be asked, and the connexions of remote parts noticed and remembered. These connexions of remote parts are so curious, the knowledge of them is sometimes so useful, and they are so immediately related to the present subject, that I may be permitted to explain them.

"During the state of excitement of the respiratory organs, a very extensive consent of the muscular frame is necessary to bind together and support the textures, that they may bear the strain, either during violent efforts of the body, as in coughing, sneezing, &c. We may take the act of sneezing as a familiar example of the manner in which the eye is guarded during a sudden and violent act of expiration.

"At the instant of this convulsive action of the respiratory muscles, a violent impulse is communicated to the head along the column of blood in the vessels of the head and neck. Every body is sensible of the eye flashing light at this moment; but the cause is mistaken, for it is supposed to be the impulse of blood forced into the eye; whereas it is the contraction of the eyelids to counteract the force of the impulse, and to guard the delicate texture of the eye. If the eyelids be held open during the act of sneezing, no sensation of light will be experienced, because the contraction of the eyelids upon the eyeball is prevented.

"Can we believe this action of the muscle of the eyelids in combination with the action of the respiratory muscles, to be an accidental connexion? Is it not rather a provision to compress and support the vascular system of the eye, and to guard it against the violent rush of blood which attends certain acts of respiration? If we open the eyelids of a child to examine the eye while it is crying, and struggling with passion, by taking off the natural support from the eye, the blood at the same time being forced violently into the head by the act of respiration, we shall see the conjunctiva suddenly filled with blood, and the eyelid everted.

"The respiratory nerve of the face performs two offices, one of which is voluntary, as in moving the cheeks and lips in speech; and the other involuntary, as in moving the nostrils in breathing during sleep or insensibility. In like manner that branch of the respiratory nerve which is prolonged to the eyelids performs a double office, contracting the eyelids by volition, and also producing those involuntary winking motions of the eyelids which disperse the tears, and preserve the lucid surface clear, whilst it causes a correspondence in the motions of the eyelids with the act of respiration.*

"But it has been observed, in the first part of this paper, that the shutting of the eyelids is not the only part of the act of preservation, and that the motions of the eyelids are attended with a rolling of the eyeball. How is this relation be-

* "Having distinguished the functions of the fifth and seventh nerves, a question still remains, whether the different operations performed by any one of them depend on the exercise of distinct filaments? I believe these filaments to be distinct nerves bound up together, and analogy would lead me to suppose them capable of distinct functions; but I cannot demonstrate this unless in the spinal nerves, where the roots are separate.

tween the eyelids and eyeball established? This leads to an examination of the fourth nerve."

On the function of the *fourth nerve* as connected with respiration and expression, we have the following explanatory remarks, offered by Mr. Bell.

"The course of inquiry leads us, in the next place, to observe the vicinity of the root of this fourth nerve to the origin of the respiratory of the face, and we find them arising from the same track of fibrous substance. The column of medullary matter which constitutes that part of the medulla oblongata from which the respiratory nerves arise, terminates upwards, or at its anterior extremity, just under the corpora quadrigemina, and there the fourth arises. Is it possible, then, we say, that there can be any correspondence between the general act of respiration, and the rolling of the eye? Led thus to make the experiment, I was gratified to find it so easy to give the proof. On stopping the nostrils with the handkerchief, every effort to blow the nose will be attended by a rapid rising of the cornea under the upper eyelid. And on every occasion when the eyelids suffer contraction through the agency of the respiratory nerve of the face, as in sneezing, the eyeball is rolled upwards, undoubtedly through the agency of the fourth nerve.

"I might, perhaps, be satisfied with having made the observation of these two facts; first, that there is such a combination of the motions of the eyeball and eyelids as I have before noticed; and secondly, that the nerves which move the eyelids, and the nerve of the obliquus muscle of the eyeball, are associated at their roots; but I should not do full justice to this interesting subject if I did not attempt something farther.

"It is plain that we must consider the nerves and muscles of the eyelids in a double capacity, in their voluntary and involuntary actions. In the first, the motions of the eyelids combine with the whole muscles of the eyeball, as we may perceive in the voluntary contractions and squeezing of the eye; but in the insensible and involuntary motions of the eyelids, there would be no sympathy with the muscles of the eyeball, and therefore no correspondence in the motion of these parts, without a nerve of the nature of the fourth; that is, a nerve which, having diverged from the root of the respiratory nerves, takes its course to the oblique muscles. In one word, the connexion of its root declares the office of this nerve.

"The expression of the eye in passion confirms the truth of this relation being established by a respiratory nerve, and consequently by a nerve of expression. In bodily pain, in agony of mind, and in all this class of passions, the eyes are raised and dragged, in conjunction with the changes to which the other features are subjected. If it be asked now, as it has been asked for some hundred years past, why the fourth nerve goes into the orbit, where there are so many nerves, why it is so distant in its origin from the other nerves, and why it sends off no twig or branch, but goes entirely to one muscle of the eye? the answer is, to provide for the insensible and instinctive rolling of the eyeball; and to associate this motion of the eyeball with the winking motions of the eyelids; to establish a relation between the eye and the extended respiratory system: all tending to the security or preservation of the organ itself."

Enumerating them in the common order pursued by anatomists, Mr. Bell thus briefly describes the functions of the ten cerebral nerves, as they are commonly, but erroneously called.

"The first nerve is provided with a sensibility to effluvia, and is properly called olfactory nerve.

"The second is the optic nerve, and all impressions upon it excite only sensations of light.

"The third nerve goes to the muscles of the eye solely, and is a voluntary nerve by which the eye is directed to objects.

"The fourth nerve performs the insensible traversing motions of the eyeball. It combines the motions of the eyeball and eyelids, and connects the eye with the respiratory system.

"The fifth is the universal nerve of sensation to the head and face, to the skin, to the surfaces of the eye, the cavities of the nose, the mouth and tongue.*

"The sixth nerve is a muscular and voluntary nerve of the eye.

"The seventh is the auditory nerve, and the division of it, called *portio dura*, is the motor nerve of the face and eyelids, and the respiratory nerve, and that on which the expression of the face depends.

"The eighth, and the accessory nerve, are respiratory nerves.

"The ninth nerve is the motor of the tongue.

"The tenth is the first of the spinal nerves; it has a double root and a double office; it is both a muscular and a sensitive nerve. It supplies the integuments and front of the head, to which the branches of the fifth do not extend."

N. (Page 288.)

After duly reflecting on the experiments of Coutanceau and Nysten on themselves, in common with those of Dr. W. F. Edwards, and Collard de Martigny, on animals, we are irresistibly led to the conclusion that the carbonic acid given out in respiration, is the product of a true secretion or exhalation from the lining or mucous surface of the lungs. Dr. Edwards found that this gas was exhaled by the mammifera, reptiles, fishes, and the mollusca—individuals of all of which classes were made to breathe hydrogen gas alone for a length of time. M. Martigny substituted azote for the hydrogen, and obtained similar results, except in the smaller quantity of carbonic acid expired. This now generally received fact is in accordance with all that we know of sound physiology, and will, we hope, serve to arrest the idle speculations of chemists on this subject. Though there is a connexion between the processes of the absorption of oxygen, and the exhalation of carbonic acid, it is not of the nature of proximate cause and direct immediate effect; but that which exists between the necessary vivifying influence of oxygen on the system at large, and of course on all the secretions, including as in the case before us, the aeriform one from the terminations of the bronchial arteries. Those who would explain the formation of the fixed air by the union of the oxygen of the inhaled air in the lungs with the carbon of the blood in the pulmonary artery—

* In this view of the fifth nerve, I have not touched upon its resemblance to the spinal nerves. But if we had ascended from the consideration of the spinal nerves to the nerves of the head, we should then have seen that the fifth was the spinal nerve of the head; that it had a ganglion at its root, a double origin, and from its power over the muscles of the jaws and mastication, that it was a double nerve in function, being that nerve which bestows sensibility at the same time that it sends branches to the original muscles; that is to say, to that class of muscles which are common to animals in every gradation. In all these respects it resembles the spinal nerves.

making the process in fact a decarbonization of the dark or black blood, at the terminations of this last mentioned vessel, strangely forget that no inconsiderable quantity of this same gas is formed on the skin, under precisely opposite conditions of the circulation, viz. the conversion of florid arterial into dark venous blood. If the carbonic acid were the direct product of the oxygen inhaled, and the carbon in the blood of the pulmonary artery, its formation ought to be suspended if the atmospheric air be withheld, and the animal left to exhaust that already in the lungs by a few respiratory movements. On the contrary, we learn on the authorities already stated, as well as of Spallanzani, that animals breathing hydrogen or azote give out the same quantity of carbonic acid as when they inhaled atmospheric air.

The proportion between the oxygen which disappears and the carbonic acid produced, varies very much, according to the species, age, and individual peculiarity of the animal.

The proportion of azote in the expired and inspired air, varies, as we are informed by Dr. Edwards, with the season. In summer, the expired air contains an excess of azote over the inspired. In winter the reverse was the case: there seemed to be an evident absorption of the gas. But still farther, he shows that both its exhalation and absorption are constantly going on, and that the predominance of one of these functions over the other, accounts for the differences just mentioned. Azote is given out when the animal breathes oxygen and hydrogen gases alone.

The four fundamental points in the function of respiration are—

1. The absorption of oxygen gas which disappears and does not circulate free or uncombined.

2. The exhalation of carbonic acid by expiration.

3. The absorption of azote.

4. The exhalation of azote.

The absorbed oxygen may in part contribute to the formation of carbonic acid in the blood: but since, in many instances animals have breathed hydrogen gas alone for a length of time, and given out carbonic acid freely by pulmonary exhalation, we must look to other sources of this acid. Of these, the digestive canal may be indicated. The experiments and observations of Jurine, Chevreul, Magendie, and others, prove that carbonic acid exists throughout the entire extent of the alimentary canal. It is formed during digestion, and to a certain amount absorbed. Dr. Desportes has related cases in which symptoms of asphyxia were induced by this cause.

M. Broussais does not make any estimate, in the text, of the capacity of the lungs, of the number of inspirations in a given time, or of the quantity of air taken in at each inspiration. Great differences of result have been obtained by different experimental physiologists on these points.

Thompson estimates that the quantity of atmospheric air generally contained in the lungs is 2294 cubic inches, and that there enters and passes out of the chest at each inspiration and expiration, 327 cubic inches. Supposing, therefore, twenty inspirations in a minute, there would enter into and pass out from the lungs in twenty-four hours, 75,556 cubic inches or 48.pounds of air.

The discrepancies of opinion already alluded to, as well as some interesting details on the subject, are well presented in the following article, which we transcribe from the ninth volume of the North American Medical and Surgical Journal, p. 189–90.

"According to the experiments of Jurine, forty cubic inches of air are expired at each natural expiration, and two hundred and twenty by a violent one. Goodwin thought that one hundred and nine cubic inches remain, after a natural expiration, in the lungs, and fourteen are introduced by a natural inspiration. Menzies procured forty for each natural inspiration, and two hundred for a forced one. Abernethy estimates each natural inspiration at twelve; Kite at seventeen; while a forced inspiration, after a forced expiration, introduces two hundred, and the air remaining in the lungs after a forced expiration is estimated to amount to eighty-seven cubic inches. Jurine admits twenty, and Delametherie only from four to six, as the amount of a natural inspiration. Sir Humphrey Davy thought that forty-one are contained after a forced, one hundred and eighteen after a natural expiration, and thirteen more after a natural inspiration. Dr. Bostock's opinion is that two hundred and eighty remain after a natural expiration, forty are added by a natural inspiration, and if we add ninety more for a forced inspiration, the lungs will contain four hundred and ten cubic inches of air. Cavallo adopts thirty inches as the amount of a natural inspiration when the respiration is performed eleven or twelve times a minute; and Abilgaard estimates a natural inspiration at only three inches. Dr. Herbst of Gottingen lately took up this subject, and performed numerous experiments in relation to it: he used a graduated glass bell-jar, capable of holding three hundred and sixty-seven cubic inches (French measure), standing in a vessel of water, and having at its summit a wide tube and stop-cock, to which was attached a glass tube of the shape of a horizontal S (∽).

"Various individuals, by practice, soon learn to breathe in this jar with the same ease as in the open air: the inspiration through the tube caused the water to rise in the jar, and the cubic quantity was ascertained by reference to the graduated scale. The verification was easily effected in any case by causing the individual to make an equal number of expirations into the jar, when previously filled with water.

"The quantity of air inhaled by short people was found to be usually from sixteen to eighteen inches, and in those of ordinary stature from twenty to twenty-five. Menzies' estimate of forty inches no man could maintain for a *short* while, without effort and uneasiness.

"The extreme capacity of inspiration and expiration differed much in different individuals. A healthy man, twenty-two years old, and five feet ten inches high, after a full expiration, inspired one hundred and eighty-four inches, and after a full inspiration, expired one hundred and eighty. A delicate young man, nineteen years old, could not inhale more than ninety, after the fullest expiration. A stout lad of sixteen, and five feet two inches high, after a full inspiration, expired one hundred and sixty inches. A little man, twenty-two years of age, and of the same stature, expired one hundred and forty-four. A little Jew, of the same age, one hundred and twenty. Fat men had commonly less capacity than others. Two stout healthy fat men, one twenty-seven, and the other thirty years of age, could not exceed one hundred and forty. The greatest capacities which Dr. Herbst had occasion to notice, were two hundred and thirty-two, and two hundred and forty-four cubic inches; the former, by a powerful young man six feet high; the latter, by a very powerful broad chested man of medium height. The effect of tight clothes was very striking; one who inspired eighty inches when dressed, inhaled one hundred and six when undressed, and his forcible efforts showed a difference of one hundred and twenty-six when dressed, and one hundred and eighty-six undressed. The difference in another, between the dressed and undressed state, was fifty and

ninety-six, and one hundred and thirty and one hundred and ninety. In women, the capacity of the lungs is inferior to that of men: a young woman, of eighteen years, expired one hundred and six inches after a full inspiration; another nineteen years old, one hundred and twenty inches. Stout women of about thirty expired from one hundred and thirty to one hundred and forty-four."

O. (Page 314.)

The mind of our author would appear, from his observations in relation to stomachic digestion, to be undecided as to the agency by which this process is effected; and although he subsequently admits (page 323) that the transformation of alimentary matter into chyme, is the result of vital chemistry, yet he appears to be in doubt whether to refer it exclusively to the vital powers of the stomach, to a solvent menstruum secreted by that organ, or to the joint operation of both. It is true, that in relation to the change which the food undergoes in the stomach, and especially, the agents by which it is accomplished, our knowledge is extremely imperfect, notwithstanding the numerous sets of experiments and the repeated discussions to which the subject has given rise. By the greater number of physiologists the action of the stomach as a vital organ upon the substances introduced into it, has been in a great measure overlooked, the whole process of chymifaction being referred to the action, solely, of a specific gastric fluid. In the conversion of the food into chyme, the language of many writers on this subject would lead us to suppose, that they consider nothing more to take place than merely a change in its consistency from a solid to a pulpy mass, and not, as actually happens in most cases, an entire change in its chemical properties. By the late experiments of Leuret and Lassaigne it is proved that all alimentary substances, with the exception of liquid albumen, undergo in the stomach a complete transformation, and that, so far at least as it regards animal principles, the change consists in their being made to approach more nearly in their nature to albumen.

In all our disquisitions upon stomachic digestion it is important to keep in mind the important fact pointed out originally by Professor Chaussier, and confirmed by the experiments of Philip, Brodie, Breschet, and Milne Edwards, that in order for food to be changed into chyme it is required that the former should be in contact with the mucous membrane of the stomach; the change taking place always from the circumference of the alimentary mass, toward the centre. A thin layer is first digested, and as it is carried forwards by the muscular action of the organ, along the greater curvature, from the cardia towards the pylorus, it becomes gradually converted in chyme; the next layer of the food undergoing in its turn a similar process. Whatever suspends or disturbs the muscular action by which the already digested food is carried into the intestines, or prevents the contact of the aliment with the inner coat of the stomach, puts an end to digestion.

The idea of digestion being effected by a gastric solvent we owe to the imaginative Van Helmont, who denominated this solvent "the animal aquafortis," or to translate more literally, the *animal solvent*. But it is to the experiments of Spallanzani and Stevens that the popularity of the doctrine has been chiefly owing.

The term solution is certainly used in a very vague sense when applied to the action of the gastric juice; whether we are to understand by it *simple solution*, that is, a solution in which the substance dissolved as well as the solvent remains

unchanged, excepting so far as the former is reduced to a fluid state; or *chemical solution*, in which both the substance and menstruum become changed in their properties—is uncertain. If the latter be the kind of solution meant, the food must then act as much upon the gastric juice as this does upon the food; the solution, also, should be governed by purely chemical laws, or else we must admit that the solvent furnished by the stomach and the varied mass constituting the food, in their action upon each other are governed by affinities and laws of action *sui generis*—in other words, that the action of the former varies with the nature of the latter, while the product is in every case very nearly the same—the predominance of albumen in the chyme, whatever may be the nature of the food employed, if the gastric fluid act chemically and is the sole agent of digestion, can in no other way be accounted for.

The experiments which have been performed with the view of proving that the gastric juice is the agent by which chymifaction is effected, from those of Spallanzani to the more recent ones of Tiedemann, Gmelin, Leuret, and Lassaigne, are altogether inconclusive. Those performed by introducing into the stomach substances enclosed in perforated tubes or in bags prove absolutely nothing. When animals were forced to swallow tubes filled with meat, previously boiled and chewed, the meat after a time was found to become softened; the softening being always in proportion to the size of the holes with which the tubes were pierced. When Spallanzani attempted these experiments upon himself with perforated tubes of wood, violent colic was produced; bags of cloth were, therefore, substituted for the tubes: when discharged from the stomach the enclosed food was, as in the former case, in a softened condition. Now, if we admit that in these cases the food was digested, we must, also, admit that it had been placed in contact with the coats of the stomach. If in any instance it can be supposed that such contact had taken place, then the experiments afford no absolute support to the doctrine of a gastric solvent. Supposing, however, that contact with the coats of the stomach did not occur, still all that can be inferred from them is that food boiled, chewed, or triturated, and soaked for hours in the juices of the stomach, will become softened—a result by no means surprising; but is it in this state converted into chyme? The fact that the contents of the tubes in the above experiments underwent merely a kind of disintegration, is rendered probable by those of Reaumur, who enclosed whole grains of barley unboiled, and others boiled and peeled, in perforated tubes, and introduced them into the stomach of a turkey, where they remained two days, undergoing no other change than becoming slightly swollen. Dr. Young of Maryland repeated these experiments upon frogs: the whole grains of corn enclosed in linen bags remained three days without change; but when beans, pease and bread well mashed were introduced, in two days the bags were found to be empty. The cohesion between the particles of the food enclosed having been so completely destroyed as to enable them to pass through the linen. When a piece of meat or more coherent articles were employed in these experiments, the tubes do not appear to have been emptied, at least in the experiments of Spallanzani; their contents being merely reduced to a pulp too consistent to pass through the perforations. If the tubes always became empty, as some, Stevens in particular, maintain, this would be a strong proof against the doctrine of a gastric solvent.—When we consider the consistence of chyme and the circumstance of the tubes being embraced by the stomach, we can see no agent, save the absorbents of the latter, capable of removing their contents.

The experiments performed by subjecting food to the action of the gastric juice

out of the stomach, are equally inconclusive with the former. In regard to all these experiments it is proper to remark—

1st. That in most, if not all of the cases in which any decided change took place, it was either bread or a portion of flesh which was subjected to the action of the gastric fluid.

2dly. The flesh was in general previously boiled, and often well mashed or chewed.

3dly. No change was produced unless the gastric fluid was heated to 100° or 102° Fahrenheit; the softening which the bread or meat underwent, being always in proportion to the degree of heat beyond this point. Cold gastric juice appeared to be perfectly inert.

4thly. It in general required from 10, 15, or in some cases 43 hours, before any considerable change in the food was produced by the action of the gastric juice out of the stomach.

5thly. No attempt has been made to compare the changes effected in alimentary substances by the action of the gastric juice out of the stomach with those which it undergoes in the process of natural chymifaction. In other words, we have been presented with no evidence that in any of these experiments the softened food approached in its chemical properties to chyme, and until this is done, they cannot with propriety be referred to as evidence of the digestive powers, properly speaking, of the gastric fluid. The language of Spallanzani in reference to the product of these artificial digestions, as they have been termed, would not lead us to suppose that he believed it to be identical with chyme; Sir George Fordyce, after a careful review of the experiments of Spallanzani, Reaumur, and Stevens, asserts positively that chyme cannot be produced out of the stomach, and in this opinion Chaussier, Magendie, and others of equal authority entirely coincide.

The experiments of Montégre in which he found no change to be produced in articles of food submitted to the action of the gastric juices, are well known. If the conclusions of Tiedemann and Gmelin, and those of Leuret and Lassaigne, are correct, it is to be presumed that Montégre failed in procuring the solution of food out of the stomach, in consequence of the fluid with which he operated not being the proper gastric juice, which according to those gentlemen is only secreted in consequence of the application of some stimulus to the stomach. It is a curious circumstance, however, that the same objection will equally apply to the gastric fluid made use of in very many of the experiments of Spallanzani and others, where a softness of the food is said actually to have taken place.

That food placed in all the chemical circumstances which can be conceived similar to those in which it is placed in a living stomach will never be converted into chyme, is a proposition long since maintained, and the correctness of which no one has yet succeeded in disproving. Let the phenomena of digestion be carefully studied, and the absurdity of supposing that the process can be imitated in inorganic vases, will be apparent. Chymifaction is so intimately dependent upon the health and integrity of the stomach, that the most trifling circumstance capable of impairing the energies of that organ, either directly or indirectly, disturbs the process or totally suspends it, and this even after it has fully commenced. Thus digestion is either impaired or prevented by nausea excited even by the imagination, by care, grief and anxiety, by the sudden report of good or bad news, by joy, anger, and close mental application, by exercise of the body after a meal, by eating too rapidly, by the presence of too small or too great a quantity of food in the stomach, and by merely, as Gosse asserts, leaning the epigastrium against

the edge of a table or other hard surface. And yet we are told that a vital process so easily disturbed can be accomplished under the most disadvantageous circumstances, out of the stomach. In some experiments performed by Dr. Beaumont, to be found in the Medical Recorder, vol. ix., meat subjected to gastric juice taken from a diseased stomach after a fast of some hours, when according to the experiments of Tiedemann, Gmelin, Leuret and Lassaigne, no gastric juice is contained in the stomach, was in a few minutes digested.

We admit that when meat, bread and a few other substances are immersed in the fluids taken from the stomach of a living animal and raised to a temperature of 100° F., they do undergo a softening or disintegration, but not from any specific solvent properties in the fluids employed. We doubt very much whether any change would be produced by this fluid if various uncooked vegetable substances were submitted to its action.

The solution of animal substances at least, may be effected under circumstances where the presence of a gastric juice cannot be suspected. Carminati digested veal with a little salt in pure water at 100° F. The veal was partly dissolved. The decanted liquor he employed in similar experiments, until, at length, he declares, that he procured a fluid possessing as active solvent properties as the gastric juice. See Journal de Physique, 1785. Struve and Maquart made an artificial solvent of a very weak solution of ammonia, which had the properties attributed to the gastric juice. See the same Journal, 1788. Dr. Smith found that the bile produced the same effects upon food as are referred by Spallanzani to the gastric juice, while the latter did not produce in his hands the effects described by that naturalist. See Transactions of the Society for the Encouragement of Arts, Manufactures and Sciences, for 1797. Montégre found that saliva with a drop or two of vinegar dissolved the food immersed in it. John Hunter put a piece of dead animal matter in pure water raised to the temperature of the living body—it lost weight—was partly dissolved; the same took place when it was immersed in the pus of an abscess. Mr. Home immersed a drachm of muscle in the matter of an abscess, and the same quantity in pure calf's-foot jelly, of the temperature of the human body; at the end of 24 hours the former was soft and pulpy, and after 144 hours that in the abscess had lost 38 grains, and was reduced to a soft and pulpy state; that in the jelly had lost 26 grains, both being free from putridity. Essay on Pus, page 32. Professor Chaussier enclosed human calculi in wounds which were then allowed to cicatrize—after a time the calculi being removed were found to have been partly dissolved. The kid or buckskin ligature when applied to a divided vessel is first reduced to a pulp and then taken up by the absorbents; see Jameson's Experiments, Medical Recorder, vol. xi.; and finally Tiedemann and Gmelin found that dilute acetic acid, dilute hydrochloric acid, a weak solution of acetate of ammonia, severally, dissolve more or less of most animal substances which are used as food. See Die Verdauung nach Versuchen, Heidelberg, 1825. It is proper to remark that all of the solvents made use of by the German experimenters exist in the juices of the stomach.

It cannot, we conceive, be denied that the gastric fluids do possess to a certain extent a solvent property—but as chymifaction is not a mere change in the food from a solid to a fluid form, but an absolute change in its chemical composition, this solvent property of the gastric juice will not of itself explain the process of stomachic digestion. This process must be referred to the vital powers of the stomach;—this organ acting upon the food introduced into it and by virtue of its functional life converting it into chyme. The exact manner in which this is effect-

ed may admit of considerable discussion. The absorbents of the stomach appear to us to be the agents by which the process is accomplished. The food softened and prepared for their action by the gastric juice, and brought in contact with the mouths of these vessels, is deprived by them of certain of its constituent principles as it slowly moves along the greater curvature of the stomach, in consequence of which a change is produced in its chemical composition, and it becomes chyme.

P. (Page 337.)

The attention of the profession has been directed with renewed interest to the cause of those perforations of the stomach frequently met with after death, and attributed by Hunter and his school to the solvent powers of the gastric juice, in consequence of a memoir presented to the Royal Academy of Medicine at Paris, by Dr. Carswell of Scotland. In this memoir, which was read before the Academy in February, 1830, Dr. Carswell maintains the correctness of Hunter's opinion in opposition to that of the majority of modern pathologists, who attribute these perforations to a morbid softening of the parietes of the stomach or ulceration. In support of his conclusion Dr. Carswell lays down the following propositions: 1. The perforations are generally observed in the great curvature of the stomach, and in the situation where the fluids must accumulate, in the ordinary position of the body. 2. When the perforation is attentively examined, it appears to have extended from a central part, on which the fluids must have rested, towards the parts to which the fluid would necessarily flow upon mechanical principles; and if the parts in the neighbourhood of the stomach be also affected, it is those only adjoining the great sac or cardiac region. 3. In the extension of the perforations, there is no indication of any morbid process; no redness, no adhesion, no formation of pus nor deposition of lymph; and this establishes a difference between perforations accomplished chemically after death, and those that take place by a morbid process during life. 4. Most generally in the chemical perforations, no effusion into the abdomen is observed. 5. The perforations have occurred in persons, who, being apparently in good health, have died suddenly. To establish the point contended for Dr. Carswell performed a series of experiments; he killed rabbits by a blow on the head after a full meal, and at an interval when digestion might be expected to be in full activity. He then suspended them by the hind legs for nine or ten hours, after which on opening them he invariably found the great curvature of the stomach, the most depending part of the organ, more or less altered. According to the interval that had elapsed after death, the coats of the stomach were either softened or completely perforated, and in the latter case, the softening often extended to the liver, the spleen, and diaphragm. Not only were the adjacent organs softened, but the same change was observed in other organs which simply touched the stomach, and to which the fluids of the latter had extended by percolation. The blood remaining in the vessels of the destroyed parts was black. Dr. Carswell found the liquid contained in the stomach to be very acid both from its smell and by its effects on litmus paper. He put portions of liquid aliment taken from the living stomach into the intestines, bladder or stomach of dead animals, and found that it destroyed them. From these experiments Dr. Carswell deduces the following conclusions: 1. Softening, erosion and perforation of the stomach, frequently occur after death, in animals killed during the digestion of a meal

2. These alterations are produced by the action of the gastric juice in its natural condition. 3. It is not necessary for their production, that the gastric juice be preternaturally acid, as Jœger imagined, or that the parietes of the stomach be previously brought by a diseased process to an unnatural state of softening, as Dr. Gairdner supposes. 4. Acidity is the essential character of the gastric juice, and the cause of its digestive properties during life, as well as of its solvent power after death. 5. The solvent power, however energetic after death, has no influence on the stomach during life. 6. And lastly, although certain erosions and perforations are undoubtedly the effect of morbid processes occurring during life, Chaussier, Broussais, and others, are mistaken in ascribing them invariably to disease. The foregoing memoir was referred to a committee, the report of which was read by M. Andral, junior, on the 25th of May, 1830. In this report it is stated that the committee had repeated the experiments of Dr. Carswell, and with similar results. They, therefore, agree with him in the general conclusions he has adduced from them. They add the fact of a mason, who was killed by a fall during the process of digestion, and in whom the mucous and muscular coats of the stomach were at several points softened and destroyed, but as they are aware that in very many cases of sudden death the stomach remains perfectly sound they cannot so positively as Dr. Carswell would, ascribe the softening in this case solely to the action of the gastric juice; nor do they believe with the latter, that the greater number of the cases of softening, erosion and perforation of the stomach, maintained by the generality of the physicians of the present day, to be the effect of disease existing during the life of the patients, are to be attributed solely to the solvent action of the gastric juice. According to Dr. Carswell, in the softenings of the stomach which occur from chemical solution, the mucous membrane is pale, transparent, and of a gelatinous consistency; and in the erosions and perforations from the same cause the circumference of the altered part presents a similar paleness and transparency. All these changes occur at the most depending part of the organ, where the gastric fluids naturally accumulate. The edges of the perforations are free, having no adhesion to the adjoining organs; no traces of a morbid action are observed in their neighbourhood; they give rise to no effusion, and finally, the blood in the vessels of the altered parts, is black or brown. 2. In the case of softening from a pathological cause, on the contrary, the mucous membrane is frequently red; but whether red or white, it is always more or less opaque, and resembles thick cream mixed with flour. The softening may occur at any part of the organ, even where the gastric juices could not have remained any time—the edges of the altered parts are not free, but adhere to the neighbouring organs, and present the indications of pre-existing morbid action.

The reading of this report elicited a long discussion. M. Piorry directed attention to the fact, that doubts have been excited as to the existence of the gastric juice; that the experiments of Montègre would appear to demonstrate, that this pretended solvent was nothing else than the saliva swallowed and acidified by the action upon it of the stomach, and he was desirous that the committee should explain the character of the fluids, which, according to M. Carswell, cause after death, the chemical solution of the parieties of the stomach. M. Carswell, he remarked, had experimented only on animals during the process of digestion, and yet, one of the most powerful causes of softening of the stomach is prolonged abstinence. It was the opinion of M. Louis, that in determining the important question advanced by M. Carswell, viz. whether the softenings, erosions and perfora-

tions of the stomach are more generally the result of disease occurring during life, or are produced after death, by the solvent properties of the juices of the stomach, it was necessary to be distrustful of the results of those experiments which are performed on living animals, as these could only furnish analogies that are frequently deceptive, and that the answer should be derived from the evidence of facts collected from the human subject. Now, these latter, he believed, would support less the opinions of M. Carswell, than of those who attributed the softening and perforation of the stomach to disease. Of twelve instances which M. Louis has detailed in his memoir upon this subject, seven he maintained, could not, evidently, be referred to a chemical solution after death. In nineteen dissections made by him very recently at the hospital of La Pitié, he detected three instances of softening of the stomach, in no one of which was it possible to explain this change according to the views of M. Carswell. In a man who had entered at La Pitié with pulmonary catarrh, who was afterwards affected for three weeks with disease of the stomach, and who finally died of anginal croup, the stomach was found softened in bands—a species of softening attributed by M. Carswell invariably to chemical solution; on the other hand, in a memoir which M. Louis had published, in relation to deaths occurring suddenly, six cases are reported in which death had taken place in individuals enjoying perfect health, and during the process of digestion; in none of which was the stomach softened. M. Louis has since observed two similar cases, one at Gibraltar, the other at La Pitié.

M. Virey remarked that the experiments of M. Carswell were performed exclusively upon herbiverous animals, in whom the gastric juice is very acid, and consequently well calculated to corrode the mucous membrane of the stomach—it was to be regretted that similar experiments had not been tried upon carniverous animals, in whom the gastric juices have less acidity. He added that certain diseases of the stomach appeared to increase the acidity of the gastric juices, and may consequently very readily induce softening and erosion of that viscus. M. Breschet during the six years he was surgeon in chief of the foundling hospital met with a great many instances of softening, erosion and perforation of the stomach. He observed them particularly in the infants which had been sent to the hospital in consequence of some disease, and which, deprived of nurses, were fed with improper food; he has never met with these changes in the stomach in infants properly nursed; he consequently attributes them to errors in diet and consequently to disease. M. Breschet cited here the authority of Cruveilhier, whose attention has been particularly directed to these softenings of the stomach, and who also has observed them frequently in infants that have been deprived of the breast; he refers them, therefore, to disease. With M. Louis, M. Rochoux considers the arguments drawn from experiments performed upon living animals inconclusive. If the juices of the stomach had the power of dissolving that organ after death, we should then find that this would occur in almost every instance where life had terminated suddenly. M. De Lens stated that several physicians, M. Sandras among others, had repeated the experiments of M. Carswell, but had not obtained from them similar results. According to M. Cruveilhier the gelatiform softening of the stomach of Jœger was undoubtedly the effect of disease; this species of softening he had observed on the anterior surface of the stomach, in the œsophagus, in the intestines, in a word in parts with which the digestive juices could not possibly remain in contact for any time. He considers, on the contrary, the pultaceous softening of Louis, as a cadaveric phenomenon; this species takes place always on the posterior surface of the stomach, where the gastric fluids naturally accumulate.

M. Lisfranc observed that in reference to the present question it was proper to recollect, that many diseases, even those which are organic, are latent, and their existence is not revealed during life by any symptoms. He has discovered in dissections cancers of the stomach considerably advanced, the presence of which had not been suspected during the lifetime of the patients. M. Castel observed that it was after life had ceased that the action of chemical agents commenced,—and although we admit that in the experiments of M. Carswell the softening of the stomach was produced by the gastric juices, the action of the latter upon the stomach occurred from the very circumstance of the digestive functions of the organ being suspended by death. In certain diseases the powers of life are so much enfeebled, that it opposes scarcely any resistance to the action of the chemical agents contained in the alimentary tube, and hence the black spots which occur in the intestines of those who have sunk under malignant diseases.

We have presented the foregoing sketch of the debate, to which the memoir of Dr. Carswell gave rise among the members of the royal academy at Paris, as it exhibits very fully the principal objections to the conclusions which that gentleman has drawn from his experiments. It is a curious circumstance, that in the perforations of the stomach recorded by Hunter, and those mentioned by Wilson Philip, and others, the food which the stomach contained was entirely unchanged, though it was the natural food of the animals examined. How is it possible, if the change in the coats of the stomach was produced by the process of digestion, to account for the food contained in the organ being unaffected, especially as the remaining life of the latter, however prompt may have been the death of the animal, would present, as we should imagine, more resistance to the action of a chemical agent than the aliment in which digestion should have taken place in the natural state of things. In the experiments of Dr. Carswell, the food in the stomach appears to have been partly digested; and here again, we meet with one of these discrepancies which mark nearly all the various sets of experiments which have been undertaken in proof of digestion by a gastric solvent, and which, independently of other circumstances, render them all to a certain degree inconclusive.

In those cases in which artificial digestion has been attempted by the action of the gastric juice out of the stomach, no effect was produced upon the food unless the gastric juice employed was raised to a temperature of 100° F. and yet, in the cases in which, after death, this very fluid is supposed to digest not only the stomach, but nearly all the abdominal viscera, its temperature could not have been much above that of the surrounding atmosphere. The animals in the experiments of Dr. Carswell, were not examined until from five to nine hours after death; and the longer the examination was delayed, the more extensively was the stomach softened. If any confidence is to be placed in the experiments of Philip, Brodie, Broughton, Breschet, Milne Edwards, and many others, digestion is completely suspended during life, and while the animal is in perfect health, by the division of the eighth pair of nerves; and yet, if we refer the softening of the stomach after death to the same process, we must admit that digestion will then go on with unexampled rapidity, notwithstanding the influence of the whole nervous system is suspended. But, in whatever light we may view these softenings of the stomach, they cannot, it is very evident, be adduced as any proof of chymification being effected by the agency of a solvent fluid secreted by the stomach.

Q. (Page 349.)

Facts do not bear out the author in his strictures on the Rasorian or Italian System of counterstimulus. A prevailing error in all his therapeutical prelections, is to regard as identical in their effects on the gastro-intestinal surfaces, various medicines of the most opposite qualities, such as calomel, the resinous drastic purgatives, antimony, and the salts of iron, zinc, &c. Though coinciding with him in his pathological premises, we do not, however, feel ourselves called on to join him in the therapeutical inferences which he thus sweepingly draws in a spirit of excessive generalization. We believe, with him, that in a large majority of fevers, and in a numerous class of chronic maladies, irritation or inflammation of the gastro-intestinal surface is the sustaining morbid cause; and that all agents which would, when taken into the stomach increase this irritation, are to be shunned;—but our knowledge of the fact, that this result follows the use of resinous drastic purgatives, is not, by any means, evidence sufficiently satisfactory for us to reprobate with equal emphasis, the use of the whole class of purgatives, still less to predicate of the injurious effects of one of the metallic salts, the similar tendency of all of this division of the materia medica. We shall best show the undue extreme to which the hypothesis of M. Broussais has led him, by laying before our readers the results of clinical experiments on the use of this antimony so denounced in the text. They are derived from the North American Medical and Surgical Journal, Vol. VIII. p. 412-13.

"1. Tartar emetic administered internally, in disease, in doses of from 8 grains to a scruple or drachm, and even several drachms during the day, is not a poison; it is not even followed by bad effects, except in a small number of cases, in which manifest counter-indications were present.

"2. Whether borne or not by the sick, it does not produce in them inflammation of the gastric intestinal mucous surface. When evidences of this phlegmasia exist, such as redness of the tongue, pain of the epigastrium, diarrhœa, we often find them disappear under its use (Laennec, Delormel, Meriadec-Laennec, Lagarde, Fontanelles); when the patient dies we commonly find the digestive tube exempt from alteration, and the internal membrane pale, or slightly injected (Meriadec-Laennec, Strambio, &c.)

"3. Tartar emetic in large doses is a powerful remedy in *peripneumony*. It is very useful either as an auxiliary to bleeding, or as the sole curative means, when sanguineous emissions have not arrested the progress of the disease, or when we deem it improper to have recourse to them.

"M. Peschier cured all his patients with the exception of one, without bleeding, and entirely with the tartar emetic. M. Wolf has cured *ten*, all that he treated; M. Palais, *one;* M. Prato, *two;* M. Rasori, *fifty-two* out of *sixty-one,* in his *civil clinic,* and *fifteen*, being the whole number, in his military clinic.

"As to the pneumonic cases which were subjected to both blood-letting and the use of the tartar emetic, we learn that Rasori cured in his civil clinic *four hundred and forty-four* out of *six hundred and two,* which makes a mortality of twenty-two out of a hundred. In his military clinic he cured a *hundred and forty-nine* out of a *hundred and seventy-five*—deaths *twenty-six*—mortality fourteen per cent. M. Laennec out of *fifty-seven* cases cured *fifty-five*—deaths *two,* which is equivalent to rather less than one in twenty-eight. M. A. Laennec cured *thirty-seven* patients out of *forty*—deaths three, or one in thirteen.

"The greater number of these persons took the tartar emetic without its producing vomiting, or at least only shortly after its first administration. In others it was

not retained on the stomach, although this circumstance was not always an obstacle to the cure.

"4. *Articular Rheumatism* is, next to pneumonia, the inflammatory affection in which the antimony in full doses has been the most efficacious. Among a great number of cases treated by M. Laennec, this professor found that the mean period of the disease under this treatment was seven or eight days. Of thirteen cases collected from his clinic, the tartrate of antimony and potass was evidently useful in *eight;* it was without effect in *two;* hurtful in *one;* and of doubtful efficacy in *two* (Meriadec-Laennec.) Out of five cases of acute articular rheumatism, M. Honore cured *four* (Lagarde.) Of fifteen cases cited by M. Delormcl, *thirteen* were followed by a cure. The *Obserever* of *Naples* contains *six* other cases of cure, *two* of which have been published by Dr. Spadafora.

"5. Tartar emetic in large doses has been tried in many other affections, but on too small a number of patients to inspire us with an entire confidence in the success of the practice.

"M. Laennec has cured, by this means, an *arachnitis*, three cases of *acute hydrocephalus*, a *phlebitis*, three cases of *chorea*, and two *anginas*. M. A. Laennec has succeeded in two cases of *idiopathic* tetanus. M. Recamier in four cases of acute pulmonary catarrh. M. Fontanelle in one of *jaundice.*

"6. In other diseases in which this mode of treatment has been tried, there are many cases of its failure, and some of its having been injurious. M. Laennec has remarked that the tartrate of antimony and potass produced a prompt reduction of the inflammatory organs in pleurisy, but that it did not hasten the absorption of the effusion which is the consequence. Out of eleven cases of apoplexy six have been cured; but as the professor made use at the same time of blood-letting, it is uncertain whether the tartar emetic contributed to the cure (Meriadec-Laennec.) In a case of rheumatism, and another of gout, it was evidently hurtful (Meriadec-Laennec.) Its employment in *insanity*, accompanied with *semi-paralysis*, was not in general attended with any success."

R. (Page 376.)

The elasticity or peculiar property of the arteries by which they are promptly restored to their original diameter, after the distending power of the blood projected from the heart is withdrawn, is of a very different nature from that evinced in the muscular tissue; and cannot depend on fibrin. The proper coat of the arteries is similar in its composition and general powers to the yellow ligaments of the vertebræ, and the posterior cervical ligaments of quadrupeds, and that by which the shells of the bivalves open, when the muscles which had kept them closed are relaxed. In all these examples, the property of contractility, which is paramount in muscle, and dependent on fibrin, is scarcely, if at all evidenced. How then can we with any propriety admit structures so opposite in their properties to be composed of the same elements; or regard that as merely a difference in degree which exists in kind.

The proportion of the yellow elastic fibrous tissue, or that constituting the proper coat of the arteries is diminished in the smaller vessels,—and in the capillaries is almost entirely wanting. It is in these latter that the chief vital phenomena of the circulation are evinced, and in which contractility is said most to prevail. We are, however, still more at a loss than in the case of the great arterial vessels, to

ascertain on what special tissue or structure their properties depend. Though compared to muscular, it is not identical with, or similar to this latter tissue either in composition or function. The contractility of the capillaries is that common to cellular tissue, of which they chiefly consist, with the greatly increased susceptibility derived from the profusion of nervous twigs so interlaced as almost to form a coat to the vessels. This arrangement is very evident in all the visceral branches of the aorta, and on very good authority we may say with Lancisi in his letter to Morgagni, that, from the ganglia of the great sympathetic, twigs are given off so numerous as to surround the arteries and be continued with them, even in the limbs, on to their termination in the veins. No doubt but there is free interweaving of the twigs of the sympathetic with the ramifications of the cerebro-spinal nerves, along the vessels, and especially towards their extremities, which will serve to explain the much greater sensibility in these latter than in the larger trunks, where the sympathetic alone forms the source of nervous supply.

The following phenomena serve to illustrate the structure and function of the arteries. The details are derived from the excellent work* of Dr. Arnott, which ought to be in the possession of every medical student.

"1. A small living artery, cut across, soon contracts so as to close its canal, and arrest hemorrhage.

"2. While an animal is bleeding to death, the arteries accommodating themselves to the decreasing quantity of blood, contract far beyond the degree to which their simple elasticity would carry them; and they relax again after death. Dr. Hales took seventeen quarts of blood from a horse before it died, in whose body only three quarts more were found altogether, and yet the moment before death the tension of the arteries sustained a column of two feet of blood in his experimental tube.

"3. The artery of a living animal, if exposed by dissection to the air, sometimes will contract in a few minutes to a great degree: and in such a case, only a single fibre of the artery may be effected, narrowing the channel like a thread tied round it. (*See Parry on the pulse.*)

"4. When a living artery is tied, the part between the ligature and the nearest branch on the side of the heart gradually contracts, and becomes at last a solid or impervious cord.

"Fluctuation in the vital action of parts, is often attended with sudden increase or diminution of caliber in the arteries concerned.

"Although these facts prove indubitably a contractility in the coats of arteries distinct from their elasticity, still, because the circular fibres do not resemble common muscles in colour or in chemical composition, or in being immediately obedient to the stimuli of electricity, pricking, great heat, &c., their contractility was by many persons for a long time denied. The dispute, however, was often more about the words *contractility* and *muscularity*, than about facts.

"The pulse in the arteries, chiefly as regards its almost instantaneous occurrence over the whole system, in all states of arterial dilatation, and its great strength and sharpness in very small and remote branches, points also to the active contractility of the arterial coats: for,

"1. Were the arterial tree in the living body a system of tubes as readily admitting of farther dilatation as in the dead body, the first part or trunk would affect the motion of the blood beyond it, nearly as the *air-vessel*, placed at the com-

* Elements of Physics or Natural Philosophy—General and Medical, &c. Philadelphia edition, 1829.

mencement of artificial arrangements of water-pipes affects the motion of the water in them;—that is to say, as this converts the sudden and interrupted jets of water from pumps of *fire engines, town-supplying pipes,* &c. into a uniform stream with scarcely a remnant of shock, so, in the arterial branches, the simple elasticity would cause a more tranquil flow and a quieter beat than that bounding pulse of life felt in the remote artery of the wrist, as sensibly, in proportion, as near the heart itself.

"2. Were the pulse a wave advancing in tubes that yielded as readily as the dead arteries in their middle states of dilatation, it would be very distinctly progressive from the heart to the extremities; but it is felt so instantly over the whole body, as to be compared commonly to a shock of electricity.

"3. A pulse may be produced artificially in the arteries of a body recently dead, by filling them with water to the tension of life, and then injecting at intervals, by a syringe, as much water as the heart throws off blood at a pulse: but although the artery is then distended nearly to the limit of its dilatability, and is therefore rendered rigid, the beats are very different from those of the living pulse. A similar experiment, tried by connecting the artery of a dead animal with the corresponding artery of a living one, has a similar result.

"4. A tube, extensively elastic, that it might convey a wave of liquid with a velocity approaching to that of the pulse, would require to be so tense, from fulness, as to be discernible always by the touch, through any imbedding medium such as flesh, like a hard cylinder or cord; and it would be acting constantly as a spring tending to straighten itself, and therefore would be stiffening the parts through which it passed. Now the living arteries, between their pulsations, are almost as soft and compressible as the surrounding flesh, and offer no perceivable opposition to bending, in any movement of the parts. This may be verified by examination of the lips, for instance, or of the fingers; but when a person sits cross-legged, the well-known shaking of the suspended foot, in unison with the pulse, shows the recurring efforts of the artery to straighten itself, during the moments of greater tension.

"5. A bulky wave in elastic vessels would have to recoil from the extremities, or to pass through them as a gush; and the recoil would be particularly observable near the ligature of a tied artery: but examination has not detected such effects in the living body. The tying of an artery *beyond* an aneurismal tumour, if it checked a strong wave, would almost certainly produce bursting; yet Mr. Wardrop and others have lately performed this operation with successful issue.

6. The wave would be more interrupted by the bandage in the operation of bleeding, than the living pulse is.

"7. The pulse of a paralytic limb often seems more affected than mere change of size in the artery would account for. The same is true, in an opposite way, of the pulse in an artery leading to an inflamed part.

"8. If the abdomen of a living animal be opened, the mesenteric artery, in all its ramifications, is seen stiffened and raised up suddenly with every pulsation, in a manner which the spreading of newly received blood in a very yielding vessel ill accounts for.

"9. In the interesting experiments of Bichat, Parry, and others, to ascertain the exact extent of the supposed dilatation and contraction of arteries during a pulse, not the slightest degree of either was discernible, even when sought for with microscopes.

"To explain these and other phenomena, then, it seems necessary to admit, as occurring throughout the whole body, and almost simultaneously with the contrac-

tion of the heart itself, such an action of the contractile fibres of the arteries, as to modify their natural elasticity, and to render them rigid enough, in all degrees of dilatation, for the heart to produce its effects through them almost as it would through tubes of metal. Dr. Young, in a paper published in the Philosophical Transactions for 1809, and characterized by the usual elegance and precision of his writings, has adduced experiments and calculations, to show that waves in elastic vessels advance more quickly than was before imagined; but the spreading of the pulse seems to be yet more rapid than his calculation anticipates.—It is evident, that when arteries, in consequence of depletion, are contracted beyond the middle station of their elasticity, their tension and power of quickly conveying the pulse must be dependent altogether on the condition of their contractile fibres.

"The careful experiments which could detect no change of size in the arteries during the pulse, while they disprove the ancient belief of a considerable tumefaction or wave passing along, or of a considerable filling and emptying of arteries, like what occurs in the heart, might also be supposed positively to disprove the occurrence of any general constriction of the vessels on their contents—but erroneously: for if a man's arterial system, considered as one cavity, be supposed to contain five pounds of blood (which is probably near the truth), and if the vessels be thought to embrace their contents, even between the pulses, with force enough to have all a rounded or cylindrical form, although remaining soft and yielding to the pressure of the finger, and if we suppose their coats during the pulse, to be thrown into a sudden contraction, as if in obedience to an electrical shock, still, because blood is incompressible, and because just as much enters the arteries with every pulse as escapes from them before the next, their bulk would not sensibly diminish by the strongest conceivable action of their coats; of which action the only sensible effects would be, that the soft, yielding, and, in some places, compressed tubes would be suddenly converted into hard or resisting cylinders; and that wherever, by any accidental pressure, an artery had been flattened, in regaining its cylindrical form it would strike or pulsate against the compressing body."

S. (Page 396.)

In recapitulating the motor powers of the circulation of the blood, we shall find them to be mainly two—the propulsive or expelling agency of the heart, and the suction agency of the capillaries. The part performed by the arteries and veins is that of tubes which accommodate themselves indeed to the varying quantity of blood, and so far modify and are modified by its momentum—preventing any waste of other powers, but which of themselves give no new power.

In addition to the observations in the last article (R.) respecting the structure of arteries, we may after Arnott say—"In any admissible view, however, of arterial action, we find that the arteries contribute to the motion of the blood, only as tubes which convey it; their tension, and therefore, the force with which the blood is pressed into the capillaries, being derived from the heart alone. Many physiologists have had a confused belief that the arteries aided actively in propelling the blood; but a very little reflection would have shown that as they have no vermicular or progressive contraction, like the intestines, they can no more *propel* the fluid within them, than any other rigid or elastic tubes.—Although they are thus in no degree instrumental in the propulsion of the blood, still by more permanently

ly enlarging or diminishing their caliber, that is, by merely becoming larger or smaller conduits, they may much influence its distribution, and the speed of its transmission."

"*The force of the Heart.*—The arterial tension of four pounds to the square inch, marked by its supporting in a tube connected with the arteries, a column of blood eight feet high, is produced by the action of the heart, but as the heart, while injecting the blood against this resistance, has moreover to overcome the *inertia* both of the quantity injected, and of the mass in the great artery, first moved by the injection, as also the *elasticity* of the vessel yielding to momentary increase of pressure, the heart must act with a force of about six pounds on the inch. Now as the left ventricle of the human heart, when distended, has about ten square inches of internal surface, the whole force exerted by it must be about sixty pounds. It is remarkable that, with this easy means of solving the question, the correct and elegant Magendie, in his recent elements of physiology, should speak of it as undetermined; and should cite, as the best approximation, an estimate from the obscure circumstance of a loaded foot shaking in unison with the pulse, when suspended in the cross-legged sitting attitude."

The power of capillary vessels to maintain a progressive motion of their contained fluids is exhibited in the inferior animals, which have no heart, as also in vegetables. We shall soon have occasion to explain the *modus operandi* of their function in our additional remarks on general absorption (U) and nutrition. (V)

"*The velocity of the circulating Blood.*—This has been much over-rated. 1st. By assuming that the ventricles of the heart are completely filled and emptied at each pulsation:—an assumption disproved by inspection of the exposed heart of a living body, and by the fact of the valves between the auricles and ventricles not closing so perfectly as quite to prevent regurgitation. 2d. By supposing the issue of blood from a wounded artery or vein to be the measure of the usual velocity. Now it would be as reasonable to suppose the issue of water from a wounded pipe connected with any reservoir to be the measure of a continued current in that pipe, although in truth, the issue would be the same even if the water in the pipe were usually at rest. 3d. By supposing the *frequency* of the pulse to be a measure. Now we know, that in diseases of debility, and in animals bleeding to death, the pulse usually becomes more frequent as it becomes more feeble and as there is less blood moving. 4th, and lastly. By supposing the *strength* of the pulse to be the measure. Now we find that the pulse in an artery just tied, and where consequently there is no current at all, is scarcely weaker than in an open artery. The common fact of a person's feet remaining stone-cold for hours, although the arteries leading to them pulsate nearly as usual, is a proof that exceedingly little blood is passing through the capillaries at the time, and that the pulse, therefore, is no measure of its speed.

The ventricles of the heart appear, under common circumstances, to throw out about an ounce and a half of blood at every contraction—or about seven pounds per minute. Now, if the body contain about twenty pounds altogether, as seems to be the case, the whole would circulate twenty times in an hour. This would give an average velocity of about eight inches per second in the aorta, but gradually less in the smaller arteries, because whenever a vascular channel subdivides, the branches taken collectively, have considerably greater area than the trunk from which they arise, and the current diminishes in a corresponding proportion, —just as the speed of a river stream is always less in the parts which are deeper and broader. The velocity in the extreme capillaries is found to be often less

than one inch per minute. In the veins, the blood must move more slowly than in corresponding arteries, in proportion as the veins are more capacious than the arteries."

We could wish to introduce here an account of the pulse, but the unexpected length to which this appendix has been already extended deters us, and we must be content to refer the reader to Parry on the Pulse—and the article on the subject in Arnott's Physics, p. 460–6. In the same chapter of this last work will be found a consideration of some cases where mechanical circumstances modify the circulation, as *in the head, the effects of position, diminished arterial tension.*

The opinions held by Dr. Barry respecting the pumping action of the veins in inspiration and their consequent agency in promoting the circulation, as well as a similar agency attributed to the heart, and the tendency towards a vacuum produced by the disposition of the lungs to collapse, by Dr. Carson, strike us as too hypothetical to allow of our giving space to a review of them in this place.

T. (Page 419.)

Dr. Anselmino, in his memoir on the chemical nature of the sweat, gives the following results:

One hundred parts of healthy human sweat, evaporated to dryness, were found to consist of—

Matter, insoluble in alcohol, (principally calcareous salts,) -	2 parts.
Peculiar animal matter of saliva, with sulphates, - - -	21
Substance soluble in weak alcohol, (ozmazome, and the muriates of soda and lime,) - - - - - - - - - -	48
Substance soluble in rectified alcohol, (ozmazome, alkaline acetates, and free acetic acid,) - - - - - -	29
	100

The sweat of persons labouring under scarlet fever, tetters and syphilis, was not sensibly different; but it was found that the product of the insensible perspiration in puerperal women abounded in acetic acid, from which the author explains the sour odour exhaled by such persons. Dr. Anselmino was unable to find the lactic acid, announced several years ago by Berzelius as the acid of perspiration, and thinks its existence in it very doubtful. On the other hand, he agrees with Thenard in finding the acetic acid united with a peculiar animal matter, which he supposes to be the substance designated by Berzelius as the lactic acid.

The volatile part of the sweat was found to be identical with the insensible perspiration.

The depurating function of the skin by the discharge of certain gaseous products, is now placed beyond doubt. Of these, carbonic acid and azote are constantly eliminated, in the proportion, says Abernethy, of two parts of the former to one of the latter. Dr. Collard de Martigny, in his memoir on the subject, informs us, that a full diet of animal food increases the relative amount of the azote, while a diet of white meats or vegetables causes the carbonic acid to predominate.

The similarity in function of the skin and lungs thus deduced analogically, is proved by the direct experiments of Dr. Edwards, in the work already cited.

He even shows that animals of the batrachia tribe will live longer deprived of their lungs than of their skin; and that in the elevated temperature of summer they not only are obliged to come up frequently to the surface to breathe, but also to go on land in order to turn to the greatest account their cutaneous respiration, which is more active than in the small quantity of air contained in the water. During a hot summer, if frogs cannot leave the water, they die. The same series of phenomena is found to take place in fishes similarly circumstanced.

The objection urged by Dr. Collard against there being a cutaneous respiration from the circumstance of the skin exhaling carbonic acid independently of the contact of oxygen, is invalidated by the occurrence of precisely the same exhalation from the lungs, even when oxygen is withheld from them. We are authorized, from our existing knowledge on this subject, in regarding the two functions, cutaneous and pulmonary, as identical, in as far as concerns the elimination of carbonic acid and azote, and we may add the absorption of oxygen and azote, if due reliance can be placed on the experiments of Abernethy. We must not forget the very important fact already noticed, p. 634, that the elimination of carbonic acid from the lungs and skin takes place under two entirely opposite states of the general circulation; viz. of the conversion of dark into red blood, in the lungs, and of red into dark, in the skin. Of course the formation of the carbonic acid in both cases can only depend on a common system of vessels, and a secretion performed under similar circumstances. Now these conditions are fulfilled by the bronchial arteries for the lungs, and the cutaneous ones for the skin, all coming from the aorta; and from their exhalent terminations is derived the carbonic acid.

U. (Page 494.)

The precise mechanism by which absorption is performed, is as yet an unsettled question. Capillary attraction is not an adequate cause of the movement of the chyle and lymph in their respective vessels, nor is successive contraction of the coats of these latter a satisfactory agency. If we search for illustration in vegetable physiology, we shall find a process very analogous in the rise of the sap in plants. Dr. Dutrochet in a late work on the Immediate Agent of the Vital Movement,* would seem to have proved that the vital impulsion, the *vis à tergo,* is communicated to the fluid in the lymphatic vessels of vegetables by the spongy terminations of the radicles of the root. Another power of a more negative kind, producing a movement of afflux or pumping, is in the leaves, evaporation from which invites fresh fluid from the parts beneath. It is this latter power which causes absorption, when the cut end of a branch is immersed in water. The distention of the vessels by the rise of their peculiar fluids, is called the *turgid state* by Dr. Dutrochet, and is kept up, according to him, by a physico-organic or vital action termed *endosmosis,* in virtue of which the small hollow organs are filled with a liquid which seems to be urged on with force, and accumulated in their cavities. The spongy terminations of the radicles are exclusive agents for the absorption of the water by which they are surrounded in all nutritive soils. They are constantly introducing, by endosmosis, this fluid into the interior of the cells composing their tissue, which is thereby rendered turgid, or filled in excess. The water thus im-

† L'Agent Immediat du Mouvement Vital, &c. Paris, 1826.

bibed by the terminations of the radicles, propels that portion precedingly introduced, and causes necessarily the rise of the sap in the vessels communicating if not continuous with the root. It is presumable from some experiments of Dr. Dutrochet, that if the cut end of a plant be immersed in a fluid destructive of its vitality, say diluted sulphuric acid, this latter will rise in the vessels, without any action whatever on their part, and merely by the movement of afflux of the leaves, already mentioned, by which they draw up the sap interposed between them and the foreign fluid; a movement which we must not confound with capillary attraction, nor the mere suction or motion of fluids to fill a vacuum, but which is a vital process dependent on the endosmosis of the leaves and their evaporating function.

The author, whom we continue to cite as authority on this occasion, illustrates the meaning he attaches to the term of endosmosis by various experiments. The process rests on a simple law which he has shown to exist, viz. that if an animal or organized membrane be interposed between two fluids of different degrees of density, the one having this property the least so, passes through the membrane to the other fluid more dense. If the motion be from without inwardly it is called *endosmosis;* but if the lighter fluid be within the cell, sac, or cavity, whatever, and the denser one external to it, the former passes out and constitutes the action called *exosmosis*. These processes of endosmosis and exosmosis are electrical phenomena and produced by electrical currents. Dr. Dutrochet could imitate them by the aid of electricity or galvanism. Thus he took a piece of chicken's cœcum, the kind of membrane on which he had before experimented, to show the passage of fluids through it in the directions above mentioned, and having tied both ends, introduced the negative pole into its interior, and placed the positive without, so that the side of the intestine was the communication between the two poles. The galvanic pile being now put in action, and the portion of the cœcum immersed in water, it was found that the cavity before empty, soon became turgid by the passage of water through the sides in the direction of the electric current, that is from the zinc or least dense to the copper or most dense pole. The result may be reversed, and exosmosis take place, by placing the positive pole within the cavity, and the negative outside, as in the case of the less dense fluid being in, and the denser out.

The hollow organs are compared by Dr. D. to Leyden jars with permeable sides, and as the current of fluid is always towards the negative pole, there will be endosmosis when their interior is in a state of negative electricity, and exosmosis when it is positively, and the exterior negatively electrified. But we are led to believe that the two processes are constantly going on at the same time—the preponderance of endosmosis causing absorption to be the most energetic, and of exosmosis making exhalation paramount.

The sap-vessels of plants, and the absorbents of animals are, we may presume, in a similar condition, and subject to the same laws. The former receive their fluid contents from the spongy extremities of the radicles or capillary portion of the roots; the latter are supplied from the spongy tissue of the membranes and capillary origin of the lacteals and lymphatics. The structure of both the radicles and membranes is vesicular, the vesicles containing a dense fluid. Through these the rarer fluid, in the soil, as regards vegetables, and on the membranes, as regards animals, permeates by endosmosis: it passes from vesicle to vesicle, and by maintaining these in a state of turgescence in excess acts as an impelling power to the fluid in the tubes in connexion with these vesicles. It might be thought that the lymphatic and lacteal glands would interrupt the passage of the lymph and chyle;

but the contrary is the case. They are provided with a capillary tissue, the endosmosis of which produces the afflux of fluid contained in the *vasa afferentia*, and at the same time the expulsion of the fluids precedingly introduced, and hence an impulse *à tergo* for the *vasa efferentia*. These glands are then in fact organs of afflux for the fluid below, and of impulse for that above—they constitute motor organs for the fluid contained in the vessels. In this respect they resemble the leaves of plants, which, independently of their agency in the afflux of the sap in the ascending vessels, are also organs of endosmosis or *vis à tergo* for its return in the descending ones of the vegetable.

Other causes of endosmosis are mentioned by Dr. Dutrochet in addition to the mere difference of density of the fluids. Their chemical composition gives rise to great variations in this respect. He shows, moreover, that there is elective absorption, and that solid or fecal matters, for example, in the intestine will, in place of being absorbed, cause exosmosis or exhalation.

In a paper contained in the American Journal of the Medical Sciences, vol. vii., Dr. J. K. Mitchell enters into a minute, elaborate and ingenious investigation of the subject of exosmosis and endosmosis, and arrives at the conclusion, in which he is sustained by numerous and diversified experiments, that the comparative readiness of fluids to pass through cellular and membranous structures is not dependent on the property or condition of the solid, but on the nature of the fluid, and hence he refers the phenomena detailed by Dutrochet to the various degrees of *penetrativeness of fluids*. The mechanical agency or motor power given by the movements of vital fluids is not denied, but the mode of agency is differently considered by Dr. Mitchell from what is laid down by Dr. Dutrochet. For further information on this curious subject the reader is referred to a paper in the same volume of the Journal just quoted, by Dr. Faust of South Carolina.

V. (Page 509.)

These opinions of the author, already explained and illustrated under the heads of the capillary circulation and the secretions and exhalations, find strong corroboration in the views and experiments of Dr. Dutrochet, which we have partially exhibited in the preceding article. The growth of parts is regarded by this physiologist as the result of endosmosis. Each vesicle entering into the composition of an organ, has, in its interior, a fluid denser than the sap of a plant, or the blood of an animal, as the case may be; of course this nutritive fluid is drawn from the vessels, and a part is introduced into the vesicle, increasing thereby its size, and giving it growth. But, as already mentioned, the inward is not the only current, since electricity, the cause of the phenomenon, gives rise to two currents in opposite directions, and of unequal force; and as that of introduction or endosmosis is stronger, the vesicle or cell is always filled in excess and preserves its turgid state. The feeble exosmosis is in degree aided by the violent entrance of new fluids which must expel some of the matters formerly introduced. There is then a continued renewal of the contents of the vesicle, in other words, a continued movement of composition and decomposition. What is said of one vesicle or cell, applies to all, the union of which constitutes the organ. But this exchange of fluids is attended by important alterations in their chemical composition, on account of its being the effect of electrical currents: and this circum-

stance will serve to explain the different nature of the matters composing the organs, and those circulating in the vessels.

Secretion may be regarded as nearly an analogous process. Each vesicle secretes its contained liquid: that is, it only allows molecules of a particular nature to permeate through its sides.

The sanguiferous system in animals, in its minuter ramifications, keeps up a kind of *irrigation* of the organs, and carries to the elementary vesicles the new organic materials, which it transmits by a kind of filtration, and not, as generally supposed, by vascular orifices. But whilst the vesicles thus receive, by endosmosis, new molecules from the blood, they expel by exosmosis others, which are carried into the general current. These phenomena, as described by Dr. Dutrochet, are in strict unison, if not identical, with those regarded by the author in the text as taking place by means of vital or organic chemistry. In speaking of the production of fatty and oily matters, he says, p. 476, "we are then compelled to allow that the cells which contain these kinds of humours, fabricate them immediately at the expense of the fluids in circulation: and since dissection cannot show us organized ducts in the form of vessels, which may be intrusted with bringing about this transformation, we are compelled to refer it to an inexplicable kind of organic action, residing in the walls of the adipose cells, and which as well as the formation of serous and synovial fluids, can only be considered as purely a phenomenon of vital chemistry." Now these are precisely the changes which Dr. Dutrochet supposes to take place by means of electricity. By both writers they are believed to occur beyond or out of the circulatory vessels, and to be accomplished by the intervention of the cells or vesicles composing the organs, without the aid of the vital properties of sensibility and contractility. Our confidence in the correctness of these views is not a little strengthened by the different manner in which their distinguished authors were led to form them—the one by induction, the other by a series of experimental observations.

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Erratum.—Page 359, line 22 from top, for "receives *vasa efferentia*," read receives *vasa afferentia*.

THE END.